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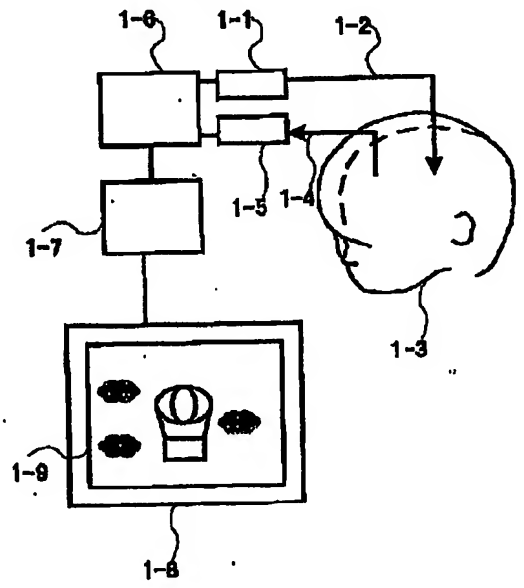
(54)【発明の名称】　生体光計測法を用いた遊戯装置

(57)【要約】
【課題】精神状態や脳活動を反映する生体内代謝物質濃度もしくはその濃度変化反映する生体内を透過した光強度の変化を計測し、その計測結果を画面上に表示したオブジェクトへ反映する遊戯装置を提供する。
【解決手段】光照射器（１－１）、（１－２）と光検出器（１－５）を被検査体（１－３）の皮膚上に接触することで、被検査体内部を伝播した光の強度を検出し、その検出結果を電子計算機（１－８）上へ伝送する。そして、その検出強度の変化に応じて、画面（１－９）中に表示したオブジェクトの位置や形状、色彩などを変化させる。マウス、ジョイスティック、ハンドルなどに代表される既存の入力装置を用いることなく、ヒトが考えていることを計測して、直接画面上のオブジェクトの状態を制御することが可能になる。

図1



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【特許請求の範囲】

【請求項１】生体に光を照射するための少なくとも一つの光照射器と、前記光照射器から照射され前記生体内を伝播した通過光を集光するための少なくとも一つの光検出器と、少なくとも一つのオブジェクトを表示する表示画面を備えた表示部と、前記光検出器で計測された前記通過光の強度に関する計測信号に基いて前記表示部を制御する演算部とを有し、かつ、少なくとも一つの前記光検出器により計測された計測信号の強度変化に応じて、前記表示画面上に表示された少なくとも一つの前記オブジェクトを含む状態が変化するよう構成したことを特徴とする生体光計測法を用いた遊戯装置。

【請求項２】複数の生体に光を照射するための少なくとも一つの光照射器と、前記光照射器から照射され前記生体内を伝播した通過光を集光するための少なくとも一つの光検出器と、少なくとも一つのオブジェクトを表示する表示画面を備えた演算部と、前記光検出器で計測された前記通過光の強度に関する計測信号に基いて前記表示部を制御する演算部とを有し、かつ、少なくとも一つの前記光検出器により計測された計測信号の強度変化に応じて、前記表示画面上に表示された一つ以上のオブジェクトを含む状態が変化するよう構成したことを特徴とする生体光計測法を用いた遊戯装置。

【請求項３】複数の生体の各々に導波路を介して光を照射するための少なくとも一つの光照射器と、該光照射器から照射され前記生体内を伝播した通過光を集光するための少なくとも一つの光検出器と、少なくとも一つのオブジェクトを表示する表示画面を備えた表示部と、前記光検出器で計測された前記通過光の強度に関する計測信号に基いて前記表示部を制御する演算部とを有し、かつ、少なくとも一つの前記光検出器により計測された計測信号の強度変化に応じて、前記表示画面上に表示された一つ以上のオブジェクトを含む状態が変化するよう構成したことを特徴とする生体光計測法を用いた遊戯装置。

【請求項４】前記光照射器と、前記光検出器と、前記記憶装置と、前記電子計算機とを情報端末に内蔵せしめ、かつ、前記光照射器および前記光検出器の一部は、前記情報端末の端子と結合するよう構成したことを特徴とする請求項１、２、又は３記載の生体光計測法を用いた遊戯装置。

【請求項５】前記演算部は、前記光照射器から光を照射した累積時間および基準照射期間を記憶する機能と音声を発するスピーカを含んでなり、かつ、前記光照射器から光を照射した累積時間が前記基準照射期間を超過した場合に、前記表示画面上の構成を変更させる指令か、もしくは前記スピーカから発する音声を変更させる指令を出すよう構成したことを特徴とする請求項１、２、又は３記載の生体光計測法を用いた遊戯装置。

【請求項６】前記演算部は、前記光照射器から光を照射した累積時間が前記基準照射期間内であっても、前記透過光の強度が所定の閾値を超過した場合に、前記表示画面上の構成を変更させるか、もしくは前記スピーカから発する音声を変更させる指令を出すよう構成したことを特徴とする請求項５記載の生体光計測法を用いた遊戯装置。

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【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、遊戯装置に係り、特に、精神状態や脳活動を反映する生体内代謝物質濃度もしくはその濃度変化を反映する生体内を透過した光強度の変化を計測する生体光計測法を用いた遊戯装置に関する。

【０００２】

【従来の技術】局在化している脳機能を測定して、外部装置へ入力することにより、コンピュータ、ゲーム、環境制御装置、学習度判定装置、乗物の警報装置、医療用診断および警報装置、うそ発見器、意思表示装置、情報伝達装置等を制御する光生体計測法を用いた生体入力装置および生体制御装置が特開平９－１４９８９４号公報にて提案されている。以下、これについて、図１９を用いて説明する。

【０００３】被検査体へ光を照射するためには、半導体レーザ、発光ダイオード、ランプに代表される光源（１９－１）と照射用光ファイバに代表される光導波路（１９－２）（以上を総称して、光照射器とする）を使用する。計測に使用する光の波長は生体組織の透過性が高い波長８００ナノメートル近傍の光を使用するのが最適ではあるが、この波長帯に限定されるものではない。

【０００４】光導波路の両端は、光源（１９－１）及び被検査体（１９－３）の皮膚上にそれぞれ接触している。生体へ照射された光は、生体組織により強く散乱される。しかし、その散乱光の一部は、運動、感覚、言語に代表される高次脳機能が集中する大脳皮質を通過し、光照射位置から約３０ミリメートル（成人の場合）離れた頭皮へ再び到達する。

【０００５】この場所で生体内を伝播した光の強度を検出するために、光検出器を配置する。この光検出器は、光ファイバに代表される光導波路（１９－４）とその一端を接触させた、フォトダイオード、光電子増倍管に代表される光電素子（１９－５）から構成される。この光検出器を用いて、光学的信号から電気的信号へ変換される。そして、この電気的信号は電子計算機（１９－６）を用いて処理する。

【０００６】ここで、体（手、足及びこれらの指など）を動かしたり物を考えたり念じたりすることで脳を活動させたと仮定する。脳が活動すると脳の活動部位へ酸素やグルコースを供給するために、大脳皮質内の血液量が二次的に変化（増加したり減少したり）する。計測に近赤外光（波長８００ナノメートル近傍）を使用すると、

血液中のヘモグロビン（酸化ヘモグロビン、還元ヘモグロビン）は、計測に使用する、この光を吸収するため、検出用光ファイバへ到達した光量は、脳活動に伴いヘモグロビン量が増加すると減少する。このため、検出した光の強度の変化は脳の活動を反映する。この光の強度変化を計測し、この計測結果を用いてコンピューターを制御することで、精神状態や脳活動を反映するヒトの思考を計測してコンピューターを制御する入力装置が実現されている。

【０００７】

【発明が解決しようとする課題】本発明では、以下に示す２つの課題を解決する。

【０００８】第１に、上記生体光計測装置を用いた遊戯装置を実現する。一般に、遊戯装置は、マウス、ジョイスティック、ハンドル、タッチパネルなどに代表される入力装置と、その入力結果をプレーヤーへ提示することが特徴である、ブラウン管ディスプレー、液晶ディスプレー、発光ダイオードアレーに代表される呈示装置を具備する。これらの既存の入力装置は、脳からの指令に基づいて手や足を動かし、これら手や足を用いてコンピューターへ脳からの指令を入力することが共通点として挙げられる。この入力に応じて、呈示装置上に表示されたオブジェクトの位置、形態、サイズに代表される「状態」が変化することで、既に様々な遊戯装置が実現されている。

【０００９】これに対して、特開平９－１４９８９４号公報にて開示された生体入力装置は、手や足を用いずヒトが考えていることをそのままコンピューターへ入力することが可能であるものの、この生体入力装置を用いた具体的な遊戯装置の実施手段は何等開示されていない。もし具体的に遊戯装置が実現されるのであれば、健常者のみならず手や足を動かすことが困難な人にとっても、新たな遊戯装置になり得、この結果、様々な人が同じ遊戯装置を用いて楽しむことが可能になる。

【００１０】そこで、本発明では、脳からの指令や脳の活動を、光脳機能計測法を用いて直接コンピューターへ入力し、その入力結果に基づく遊戯装置を実現することを第１の目的とする。

【００１１】具体的には、第一に、ヒトが物を考えたり、物を念じたり、手や足を動かそうとする時に活性化するヒト脳機能を、光を用いて計測する。第二に、このヒト脳機能の活動の計測結果を、電子計算機の画面上に表示したオブジェクトへ反映することを可能にする遊戯装置を実現する。

【００１２】第２に、本発明では、上記遊戯装置において、プレーヤーがゲームに集中し過ぎることで疲労を感じさせないゲームのコンテンツを提供することを第２の目的とする。

【００１３】上記の遊戯装置は、ヒトの脳活動を用いてコンピューターを制御する。言い換えれば、頭を使いヒトの脳活動を制御するため、頭を使うために疲労する可能性がある。また、作成したゲームのコンテンツがプレーヤーにとって面白い場合、時間が経過するのを忘れてゲームに熱中してしまい、その結果疲労を感じてしまう可能性もありえる。そこで、このように疲労を感じさせないゲームの実施例を提供する。

【００１４】

【課題を解決するための手段】ヒトの脳は、ブロードマンの脳地図で表現される様に、異なる細胞構築で計測領域分割されている。更に、これらの各領域は、異なる機能を分担している。例えば、脳を横から見ると自発的な運動（手、足、指など）に関与する領域は頂上部、感覚、視覚に関与する領域は後頭部、言語に関する領域は左半分の所定部で分担している。

【００１５】本発明では、このように特定された場所からの情報を高精度で抽出するために、空間分解能の高い生体光計測法を使用する（脳波の計測では、生体中の誘電率が不均一であるために、信号の発生場所が不明確になり空間分解能が低い。また、被験者の体の動きに対して、筋電位が大きく信号に反映するため、被験者を拘束するという難点もある）。

【００１６】この生体光計測法は、単数もしくは複数の被検査体の皮膚上に、少なくとも一つの光照射器と、該光照射器より被検査体皮膚が照射されることにより、該被検査体皮膚内部の通過光を集光し、この集光された被検査体通過光強度を計測するための、被検査体皮膚上に配置された少なくとも一つの光検出器と、これら光照射器および光検出器を用いて計測された生体内代謝物質の濃度変化を計算する演算部から構成されている。

【００１７】そして、本発明に基づく遊戯装置では、この生体光計測法の演算部は、表示画面を具備する表示部と接続していることが特徴である。そして、この表示部中の表示画面には、少なくとも一つのあるオブジェクトが表示されている。このオブジェクトの位置、形態、サイズに代表される「状態」は、生体内を透過した信号光の強度変化に応じて変化することが特徴である。これによって、脳活動に伴う生体内代謝物質の濃度変化を可視化することが可能になる。この結果、被検査体は自らの脳を活動させることで、画面上に表示されたオブジェクトの位置、形態、サイズに代表される「状態」を変化させることが可能になり、本発明が目的とする遊戯装置が実現できる。なお、演算部と表示画面とは一体であっても、独立した構成であってもよい。

【００１８】このように、本発明は、生体に光を照射するための少なくとも一つの光照射器と、前記光照射器から照射され前記生体内を伝播した通過光を集光するための少なくとも一つの光検出器と、少なくとも一つのオブジェクトを表示する表示画面を備えた表示部と、前記光検出器で計測された前記通過光の強度に関する計測信号に基いて前記表示部を制御する演算部とを有し、かつ、

少なくとも一つの前記光検出器により計測された計測信号の強度変化に応じて、前記表示画面上に表示された少なくとも一つの前記オブジェクトを含む状態が変化するよう構成したことを特徴とする生体光計測法を用いた遊戯装置を提供する。

【００１９】また、本発明は、複数の生体に光を照射するための少なくとも一つの光照射器と、前記光照射器から照射され前記生体内を伝播した通過光を集光するための少なくとも一つの光検出器と、少なくとも一つのオブジェクトを表示する表示画面を備えた演算部と、前記光検出器で計測された前記通過光の強度に関する計測信号に基いて前記表示部を制御する演算部とを有し、かつ、少なくとも一つの前記光検出器により計測された計測信号の強度変化に応じて、前記表示画面上に表示された一つ以上のオブジェクトを含む状態が変化するよう構成したことを特徴とする生体光計測法を用いた遊戯装置を提供する。

【００２０】また、本発明は、複数の生体の各々に導波路を介して光を照射するための少なくとも一つの光照射器と、該光照射器から照射され前記生体内を伝播した通過光を集光するための少なくとも一つの光検出器と、少なくとも一つのオブジェクトを表示する表示画面を備えた表示部と、前記光検出器で計測された前記通過光の強度に関する計測信号に基いて前記表示部を制御する演算部とを有し、かつ、少なくとも一つの前記光検出器により計測された計測信号の強度変化に応じて、前記表示画面上に表示された一つ以上のオブジェクトを含む状態が変化するよう構成したことを特徴とする生体光計測法を用いた遊戯装置を提供する。

【００２１】また、本発明は、前記構成において、光照射器と、光検出器と、表示部と、演算部とを同一の情報端末に内蔵せしめ、かつ、光照射器および光検出器の一部は、前記情報端末の端子と結合するよう構成したことを特徴とする生体光計測法を用いた遊戯装置を提供する。

【００２２】さらに、本発明は、前記構成において、演算部は、光照射器から光を照射した累積時間および基準照射期間を記憶する機能と音声を発するスピーカを含んでなり、かつ、光照射器から光を照射した累積時間が基準照射期間を超過した場合に、表示画面上の構成を変更させる指令か、もしくはスピーカから発する音声を変更させる指令を出すよう構成したことを特徴とする生体光計測法を用いた遊戯装置を提供する。

【００２３】さらにまた、本発明は、前記構成において、演算部は、光照射器から光を照射した累積時間が前記基準照射期間内であっても、透過光の強度が所定の閾値を超過した場合に、表示画面上の構成を変更させるか、もしくはスピーカから発する音声を変更させる指令を出すよう構成したことを特徴とする生体光計測法を用いた遊戯装置を提供する。

【００２４】

【発明の実施の形態】本発明では、光を用いて局在化している脳機能の活動状況を計測し、計測した信号を、例えば電子計算機等の演算部の入力信号として用いる。具体的には、一つ以上の光照射器と一つ以上の光検出器を一人以上の被検査体の皮膚上に接触し、生体内を透過した光の強度変化を計測する。この計測結果は、脳活動に伴う生体内代謝物質（酸化ヘモグロビン、還元ヘモグロビンなど）の濃度変化を反映する。この計測結果が演算部への入力信号として利用される。演算部に接続された表示部には被検査体への表示（呈示）画面が存在し、その画面上には一つ以上のオブジェクトが存在する。生体内代謝物質の濃度もしくは濃度変化、すなわち、この濃度もしくは濃度変化を反映する演算部への入力信号強度の変化（もしくは生体内を透過した光の強度変化）に応じて、一つ以上のオブジェクトの形態（位置、色彩、サイズなど）が変化する。

【００２５】すなわち、光を用いて脳機能を計測し、脳機能の活動状態に応じて電子計算機等の演算部へ接続した表示画面上のオブジェクトの状態が変化する遊戯装置が実現できる。

【００２６】以下、図を用いて本発明に関する実施例を具体的に説明する。

【００２７】図１は、一人のプレーヤー上に一つの光照射手段と一つの光検出手段を用いて、生体内の代謝物質（例えば、血液中の酸化ヘモグロビンや還元ヘモグロビン、チトクロムなど）の濃度もしくはその濃度変化を計測し、画面に表示されたオブジェクトに対して、生体内組織伝播光強度に依存する脳活動を反映する遊戯装置を実現する一実施例を示す。１－１は半導体レーザ、発光ダイオード、ランプに代表される光源であり、その先端は光導波路（例えば、光ファイバ）１－２と接続している。

【００２８】光ファイバのもう一端は、被検査体（１－３）の皮膚上（例えば頭皮上）に接触している。頭皮上に接触する場合は、頭皮上に存在する髪の毛を掻き分け、頭皮上に直接光導波路の先端が接触していることが望ましい。何故ならば、計測に使用する光が髪の毛によって吸収されてしまうと、光照射効率が低下するためである。

【００２９】１－４は、光導波路（１－２）よって照射され、検査体（１０３）内部を伝搬した光を検出するために使用する検出用の光ファイバである。この光ファイバ（１－４）の一端は、被検査体（１－３）の皮膚上（例えば頭皮上）に接触している。この光ファイバの一端も、同様の理由により、頭皮上に存在する髪の毛を掻き分け、頭皮上に直接光導波路の先端が接触していることが望ましい。また、もう一端は、アバランシェホトダイオード、光電子増倍管に代表される光検出器（１－５）に接続している。これら光源（１－１）と光検出器

（１－５）は、制御装置（１－６）と電気的に接続されている。この制御装置（１－６）は、アナログディジタル変換器（１－７）を介して、電子計算機等に代表される演算部（１－８）と接続している。

【００３０】この制御装置（１－６）と演算部（１－８）は、相互に双方向の情報の伝送が可能である。制御装置（１－６）は、光源に対して光量の調整（例えば、光源のオンもしくはオフ、パルス状の光源を発生する、光源の発光強度をある角周波数で変調する）を実施することが可能である。

【００３１】また、演算部（１－８）は、検出した光の強度変化（時刻依存性）の情報を一時的もしくは永久的に蓄えるために、記憶装置（例えば、ハードディスク、メモリ）を具備している。光検出器（１－５）に到達したアナログ的な光強度は、アナログディジタル変換器（１－７）を介してディジタル的な光強度に変換され、その結果は演算部（１－８）へ伝送される。

【００３２】また、演算部（１－８）から制御装置（１－６）へは、光源の光量調整を指示する信号が伝送される。本実施例では、制御装置（１－６）、アナログディジタル変換装置（１－７）、演算部（１－８）は別々の独立した装置構成になっているが、一体化した装置構成であっても何等問題は無い。

【００３３】また、電子計算機（１－８）上には、画面に表示されたオブジェクトに対して、生体内組織伝播光強度に依存する脳活動を反映する遊戯装置を実現するために、表示画面（１－９）を備えた表示部を有する。この表示画面（１－９）の構成に関しては、別の実施例を用いて説明する。なお、この表示部は、演算部とは一体構成であっても、別々の独立した装置構成であってもよい。

【００３４】次に、図２に示した計測方法を用いて、生体内代謝物質濃度の変化を計測する方法を説明する。

【００３５】まず、図２に示した計測方法を用いて、光照射用光導波路（２－１）と検出用光導波路を（２－２）を被検査体（２－３）の頭皮上に接触させる。ヒトの脳は、頭皮の内側に、頭蓋骨（２－４）、脳脊髄液層（２－５）、大脳皮質（２－６）などが層状に存在する。ここで、光照射用光導波路（２－１）と検出用光導波路（２－２）は、被検査体（２－３）が痛みを感じない様に、頭皮上に軽く接触させる。

【００３６】ここで、生体組織は光を強く散乱する。このため、散乱された光の一部は、図２（ａ）に示すように、頭蓋骨（２－４）の内側に存在しヒト固有の高次脳機能が集中している大脳皮質（２－６）を経由し、検出用光導波路（２－２）と被検査体（２－３）の頭皮の接触位置へ到達する。この到達位置は、光照射位置（光照射用光導波路（２－１）の頭皮上での接触位置）から、成人の場合、一般的に約３０ｍｍ離れている。

$$x = \ln\{(t=0\text{での検出光強度}) / (\text{時刻}t\text{での検出光強度})\} \quad \cdots\cdots\cdots\cdots\cdots \text{式（１）}$$

この式（１）によれば、透過光強度が減少するとｘは増加し、一方、透過光強度が増加するとｘは減少する。このため、脳が活動すると気球の高さは高くなることが分かる。以上の方法を用いることで、第一に、ヒトが物を

【００３７】ここで、脳が活動すると、図２（ｂ）に示すように、脳神経細胞の活動部位へ、酸素やグルコースを供給するために、大脳皮質内の血液量（酸化ヘモグロビン濃度、還元ヘモグロビン濃度）が変化する（２－７）。計測には、生体組織透過性が高く（生体中の水やタンパク質に計測され難く）、血液中のヘモグロビン（酸化ヘモグロビン、還元ヘモグロビン）により吸収される近赤外光（波長：８００ナノメートル前後）を使用するのがもっとも望ましい。もちろん、この波長体の光に限定されるものでは無い。ここで、脳が活動することで、大脳皮質の血液量が増加（減少）すると、検出される光の強度は減少（増加）する。

【００３８】次に、図１に示した計測システムを用いて、画面に表示されたオブジェクトに対して、生体内組織伝播光強度に依存する脳活動（神経活動）を反映する遊戯装置のコンテンツの一実施例を示す。

【００３９】まず、図３（ａ）中の３－１に、生体組織を透過した光の強度と計測時間の関係例を示す。この計測では、図１に示した光照射用光ファイバと光検出用光ファイバを、或る被検査体の左眉毛上１センチメートルの「額」上に３０ｍｍ間隔で配置した。この図中の計測期間（５０秒）中、１０秒から３０秒（２０秒間）では、被検査体は、その右手を１Ｈｚで、「グー」と「パー」を繰り返した。一方、これらの時間中では、被検査体は安静な状態を取った。この計測結果から、タスク開始後数秒後に検出光強度が減少し、タスクが終了すると検出光強度は増加していることが分かる。これは、脳の活動により、生体内の代謝物質濃度（ヘモグロビン濃度）が増加していることと対応している。

【００４０】そこで、図３（ｂ）中の３－２に示すようなコンテンツの一実施例を提供する。このコンテンツでは、画面上に気球（３－３）が存在する。この気球は、地面（３－４）に対して高さｘの位置に存在する。

【００４１】この高さｘの決定方法は、例えば、生体組織を透過した光の強度と計測時間の関係例（３－１）に倣うと以下のように決定される。式（１）中のｔ＝０での検出光強度は或る基準強度であり、計測期間中（遊戯装置実施期間中）の任意時刻における強度であっても、この期間中の平均値であっても、また、これ以外に任意に決定した基準強度であっても構わない。勿論、この式（１）を用いた決定方法に限定されるものでは無い。

【００４２】

考えたり、物を念じたり、手や足を動かそうとする時に活性化し、不可視であるヒト脳機能を計測し、第二にその結果を直接電子計算機へ入力し、第三に、このヒト脳機能を可視化し、言い換えれば、脳活動に応じて画面上に表示されたオブジェクトが変化する遊戯装置を実現することができた。

【００４３】以上述べた実施例の変形例を、以下に述べる。

【００４４】図４は、被検査体の皮膚上に複数の計測点を設定し、これら複数計測点での代謝内物質濃度の濃度変化を計測する。そして、これら濃度変化の計測結果に基づいて、画面に表示されたオブジェクトに対して、生体内組織伝播光強度に依存する脳活動を反映する遊戯装置を実現する実施例を述べる。４－１は、半導体レーザ、発光ダイオード、ランプに代表される光源である。この発光強度は、制御装置（４－２）により制御され、４－１および４－２は電気的に結合している。

【００４５】半導体レーザ、発光ダイオード、ランプに代表される光源（４－１）のもう一端は、光ファイバに代表される光導波路（４－３）に接続し、この光ファイバは、更に、光結合器（４－４）により、複数の光ファイバに代表される照射用光導波路（４－５）に接続している。これら複数の光ファイバの先端は、被検査体（４－６）の皮膚上の複数点上にて接触している。例えば、それぞれ左右の側頭葉に配置することが考えられる。勿論、この配置方法に限定されるものではなく、被検査体の皮膚上における任意の点に配置しても構わない。各光ファイバに代表される照射用光導波路（４－５）の先端から数センチメートル離れた場所に、検出用の光ファイバに代表される光導波路（４－７）を配置する。例えば、計測対象が、ヒト脳機能の活動に伴う生体内代謝物質の濃度変化（血液量変化）であるのであれば、３センチメートル程度にするのが望ましいが、勿論、この値に限定されるものでは無い。

【００４６】この検出用の光ファイバに代表される光導波路（４－７）のもう一端は、アバランシェホトダイオード、光電子増倍管に代表される光検出器（４－８）に接続している。この光検出器（４－８）により、生体内を伝搬した光の強度は、電気的な信号強度に変換される。そして、電気的に結合した制御装置（４－２）へ入力される。制御装置（４－２）へ入力されたこの信号強度は、アナログデジタル変換器（４－９）へ入力され、そのディジタル信号は、演算部（画面制御装置）（４－１０）へ入力される。本実施例では、この画面制御装置（４－１０）は、表示画面（４－１１）を具備している。表示画面上に表示されるコンテンツは後述する。以上述べた計測方法を用いると、以下に述べる画面に表示されたオブジェクトに対して、生体内組織伝播光強度に依存する脳活動を反映する遊戯装置を実現することができる。

【００４７】図４に示した光ファイバに代表される照射用光導波路（４－５）は、頭皮上の複数点に配置されている。ヒト脳機能は、機能毎に大脳皮質上に局在化している。例えば、この光導波路の一本を、左側頭葉上に、もう一本を右側頭葉上に設置すると、それぞれ、右指運動野、左指運動野の脳活動を計測することが可能になる。別の言い方をすれば、右手の指を動かすことで、左側頭葉を活性化することができ、その結果、被検査体（４－６）の頭皮上に設置した照射用光導波路（４－５）と検出用の光ファイバに代表される光導波路（４－７）を用いて、左側頭葉での脳の活性化を計測することが可能になる。同様に、左手の指を動かすことで、右側頭葉を活性化することができ、その結果、被検査体（４－６）の頭皮上に設置した照射用光導波路（４－５）と検出用の光ファイバに代表される光導波路（４－７）を用いて、右側頭葉での脳の活性化を計測することが可能になる。このように、複数の計測点を設置することで、複数種類の脳活動を計測することが可能になる。

【００４８】そこで、表示画面（４－１１）上に表示するオブジェクトに対して、生体内組織伝播光強度に依存する脳活動を反映する遊戯装置を実現する方法を、図５により説明する。５－１は表示画面であり、この表示画面では、カヌーを用いた川下りを表現している。５－２は川岸であり、カヌー（５－３）は川岸に囲まれた川の中を航行する。このカヌーは、予め電子計算機上に記憶された地点毎の流速に従い、上流（５－４）から下流（５－５）へ航行する。

【００４９】図５中の５－６は、障害物であり、この障害物にカヌー（５－４）が接触すると、カヌーは航行しなくなる。５－６に述べた障害物は、例えば、川の中に存在する岩や流木などを想定していて、図５中に表示した障害物の形状に限定されるものでは無い。図５中に示した破線形状のカヌー（５－７）は、時系列に推移した川の中でのカヌーの位置であり、障害物（５－６）に接触することなく、川の中を進んでいる。この様に川の中を進むためには、左右の指を運動させることで、左右の側頭葉に存在する指運動野を独立して活性化させれば良い。

【００５０】この結果、画面に表示されたオブジェクト（図５の場合、カヌー（５－３））に対して、生体内組織伝播光強度に依存する脳活動を反映する遊戯装置を実現することができる。

【００５１】以上述べた光を用いた脳機能計測法には、磁気を用いた脳機能計測法（例えば、機能的磁気描画装置）、電気を用いた脳機能計測法（例えば、脳波計）、放射線を用いた脳機能計測法（例えば、陽電子照射断層像描画装置）には無い優れた特徴がある。それは、装置が小型であっても、局在化したヒト脳機能を安全に計測することが可能であることである。このため、複数人のヒト脳機能を同時に計測することも可能である。そこ

で、複数人のヒト脳機能を同時に計測し、その結果、画面に表示されたオブジェクトに対して、生体内組織伝播光強度に依存する脳活動を反映する遊戯装置を実現する実施例を用いて説明する。

【００５２】図６は、複数の被検査体を同時計測する場合の実施例の一形態である。６－１は、半導体レーザ、発光ダイオード、ランプに代表される光源である。この発光強度は、制御装置（６－２）により制御され、６－１および６－２は電気的に結合している。半導体レーザ、発光ダイオード、ランプに代表される光源（６－１）のもう一端は、光ファイバに代表される光導波路（６－３）に接続し、この光ファイバは、更に、光結合器（６－４）により、複数の光ファイバに代表される光導波路（６－５）に接続している。これら複数の光ファイバの先端は、被検査体１（６－６）および被検査体２（６－７）の皮膚上に各々接触している。

【００５３】各光ファイバに代表される照射用光導波路（６－５）の先端から数センチメートル離れた場所に、検出用の光ファイバに代表される光導波路（６－８）を配置する。例えば、計測対象が、ヒト脳機能の活動に伴う生体内代謝物質の濃度変化（血液量変化）であるのであれば、３センチメートル程度にするのが望ましいが、勿論この値に限定されるものでは無い。

【００５４】この検出用の光ファイバに代表される光導波路（６－８）のもう一端は、アバランシェホトダイオード、光電子増倍管に代表される光検出器（６－９および６－１０）に接続している。この光検出器により、生体内を伝搬した光の強度は、電気的な信号強度に変換される。そして、電気的に結合した制御装置（６－２）へ入力される。制御装置へ入力されたこの信号強度は、アナログデジタル変換器（６－１１）へ入力され、そのディジタル信号は画面制御装置（６－１２）へ入力される。この画面制御装置は、表示画面（６－１３）を具備している。表示画面上に表示されるコンテンツは後述する。

【００５５】以上述べた計測方法では、アバランシェホトダイオード、光電子増倍管に代表される光検出器（６－９および６－１０）が複数個所要となった。そこで、より少ない検出器の個数にて、複数の被検査体を同時に計測することが可能な計測法を、以下の実施例において図７により説明する。７－１は、半導体レーザ、発光ダイオード、ランプに代表される光源である。この発光強度は、制御装置（７－２）により制御され、７－１および７－２は電気的に結合している。

【００５６】半導体レーザ、発光ダイオード、ランプに代表される光源（７－１）のもう一端は、光ファイバに代表される光導波路（７－３）に接続し、この光ファイバは、更に、光結合器（７－４）により、複数の光ファイバに代表される光導波路（７－５）に接続している。これら複数の光ファイバの先端は、被検査体１（７－６）および被検査体２（７－７）の皮膚上に各々接触している。

【００５７】各光ファイバに代表される照射用光導波路（７－５）の先端から数センチメートル離れた場所に、検出用の光ファイバに代表される光導波路（７－８）を配置する。例えば、計測対象が、ヒト脳機能の活動に伴う生体内代謝物質の濃度変化（血液量変化）であるのであれば、３センチメートル程度にするのが望ましいが、勿論この値に限定されるものでは無い。この検出用の光ファイバに代表される光導波路（７－８）のもう一端は、光結合器（７－９）に結合している。

【００５８】この光結合器からの出力は、光ファイバに代表される光導波路（７－１０）を介して、アバランシェホトダイオード、光電子増倍管に代表される光検出器（７－１１）に接続している。この光検出器により、生体内を伝搬した光の強度は、電気的な信号強度に変換される。そして、電気的に結合した制御装置（７－２）へ入力される。制御装置へ入力されたこの信号強度は、アナログデジタル変換器（７－１２）へ入力され、そのディジタル信号は画面制御装置（７－１３）へ入力される。この画面制御装置は、表示画面（７－１４）を具備している。また、光結合器（７－４）は、制御指令伝送用回路（７－１５）を介して、制御装置（７－２）と結合している。

【００５９】この図７に示した計測方法では、一つの光源（７－１）からの光を複数の被検査体（７－６、７－７）へ照射し、各被検査体内を伝搬した光強度を一つの光検出器（７－１１）を用いて検出する。検出した光が、どちらの被検査体を伝搬した光であるかを明らかにするために、以下の図８に示す制御シーケンスを設ける。８－１は、制御装置（７－２）から光結合器（７－４）へ発せられる制御用パルスである。このパルスの照射間隔は、例えば１００ミリ秒とするが、勿論この値に限定されるものでは無い。

【００６０】この制御用パルスを光結合器（７－４）が受信すると、８－２および８－３が示す様に、照射用光ファイバ（７－５）を介して、被検査体１（７－６）および被検査体２（７－７）へ照射される光強度は、交互に切り替わる。８－４および８－５は、検出用の光ファイバに代表される光導波路（７－８）により検出した被検査体１（７－６）および被検査体２（７－７）の内部を伝搬した光の強度であり、各々８－２および８－３に示した光強度の時刻依存性に同期して検出することができる。これらの光強度は、光結合器（７－９）を介して、光検出器（７－１１）にて電気的信号へ変換される。変換された結果は、制御装置内にて、８－１は、制御装置（７－２）から光結合器（７－４）へ発せられる制御用パルス（８－１）に同期して、各被検査体（７－６、７－６）を透過した光強度毎に弁別することが可能になる。

【００６１】以上、図６もしくは図７に示した計測方法を用いて、画面制御装置（図６中の６－１３もしくは図７中の７－１４）上に表示するオブジェクトに対して、生体内組織伝播光強度に依存する脳活動を反映する遊戯装置を実現する方法を、図９により説明する。

【００６２】図９には、被検査体１（９－１）および被検査体２（９－２）が表示されている、対戦型綱引きを示している。各被検査体（被検査体１および被検査体２）の脳活動に伴う血液量変化は、例えば、式１に示した算出方法で計算する。例えば、被検査体１（９－１）の血液量変化（Ｂ１）および被検査体２（９－２）の血液量変化（Ｂ２）である場合、各血液量変化の差は（Ｂ１－Ｂ２）で与えられる。図９中の９－３は、この差を表示するインジケーターであり、この図中ではＢ１－Ｂ２＝２である場合を表示している。

【００６３】この図中では、Ｂ１－Ｂ２の変域は、－５から＋５までを表示しているが、勿論この変域に限定されるものでは無い。被検査体毎および計測部位毎に（照射用光ファイバと検出用光ファイバを設けた場所毎に）脳の活動量は異なる。この結果、画面制御装置（図６中の６－１３もしくは図７中の７－１４）上に表示するオブジェクトに対して、生体内組織伝播光強度に依存する脳活動を反映する遊戯装置を実現することができる。

【００６４】図１０は、図４および図６に示した計測方法の変形例である。１０－１は、半導体レーザ、発光ダイオード、ランプに代表される光源である。この発光強度は、制御装置（１０－２）により制御され、１０－１および１０－２は電気的に結合している。半導体レーザ、発光ダイオード、ランプに代表される光源（１０－１）のもう一端は、光ファイバに代表される光導波路（１０－３）に接続している。複数の光ファイバの先端は、２本ずつ、被検査体１（１０－４）および被検査体２（１０－５）の皮膚上に各々接触している。

【００６５】各光ファイバに代表される照射用光導波路（１０－３）の先端から数センチメートル離れた場所に、検出用の光ファイバに代表される光導波路（１０－６）を配置する。例えば、計測対象が、ヒト脳機能の活動に伴う生体内代謝物質の濃度変化（血液量変化）であるのであれば、３センチメートル程度にするのが望ましいが、勿論この値に限定されるものでは無い。

【００６６】この検出用の光ファイバに代表される光導波路のもう一端は、アバランシェホトダイオード、光電子増倍管に代表される光検出器（１０－７）に接続している。この光検出器（１０－７）により、生体内を伝搬した光の強度は、電気的な信号強度に変換される。そして、電気的に結合した制御装置（１０－２）へ入力される。制御装置へ入力されたこの信号強度は、アナログデジタル変換器（１０－８）へ入力され、そのディジタル信号は画面制御装置（１０－９）へ入力される。この画面制御装置は、表示画面（１０－１０）を具備している。

【００６７】次に、図１０の表示画面（１０－１０）上に表示されるコンテンツの一実施例を述べる。図１０の実施例で用いた光ファイバは、例えば、左右の側頭葉上（運動野上）に配置する。前述した通り、例えば、左右の手の指を運動させると、左右の運動野を独立に活性化することが可能になる。そこで、左右の運動野を活性化させることで、画面に表示されたオブジェクトに対して、被検査体の意志を反映することが可能になる。複数の被験者を計測対象としているため、被検査体同士が競争を行うことが可能になる。この競争遊戯装置を実現することが可能な実施例を、図１１により説明する。

【００６８】１１－１は表示画面であり、この表示画面では、カヌーを用いた川下りを表現している。１１－２は川岸であり、カヌー１（１１－３）およびカヌー２（１１－４）は川岸に囲まれた川の中を航行する。このカヌーは、予め電子計算機上に記憶された地点毎の流速に従い、上流（１１－５）から下流（１１－６）へ航行する。１１－７は障害物であり、この障害物にカヌー（１１－３、および１１－４）が接触すると、カヌーは航行しなくなる（この地点での下流方向への流速はゼロになる）。

【００６９】１１－７に示した障害物は、例えば、川の中に存在する岩や流木などを想定していて、図１１中に表示した障害物の形状に限定されるものでは無い。図５中に示した破線形状のカヌー１（１１－８）およびカヌー２（１１－９）は、時系列に推移した川の中でのカヌーの位置であり、障害物（１１－７）に接触することなく、川の中を進んでいる。この様に川の中を進むためには、左右の指を運動させることで、左右の側頭葉に存在する指運動野を独立して活性化させれば良い。この結果、画面に表示されたオブジェクト（図１１の場合、カヌー（１１－３および１１－４）に対して、生体内組織伝播光強度に依存する脳活動を反映する遊戯装置を実現することができる。

【００７０】光を用いた生体計測法は半導体レーザ、発光ダイオードに代表される半導体製光源とフォトダイオードに代表される半導体製検出器を使用することが可能であるため、装置を小型化することが可能になる。この小型化した計測装置および、画面に表示されたオブジェクトに対して、生体内組織伝播光強度に依存する脳活動を反映する遊戯装置を実現する実施例を、図１２に示す。

【００７１】図１２中、１２－１は、表示画面１２－２を具備することが特徴である情報端末である。この情報端末の下部には、光源及び検出器を具備することが特徴である制御装置（１２－３）が接続されている。この制御装置の内部構造の実施例は、図１３にて説明する。制御装置の一端には、照射用光ファイバ（１２－４）と検出用光ファイバ（１２－５）が接続されている。これら

の光ファイバの先端は、被検査体（１２－６）の皮膚上に軽く接触している。表示画面上には、脳活動を反映するオブジェクト（１２－７）が表示されている。本実施例では、脳活動に伴う血液量変化の多寡に応じて高さが変化する気球を表示しているが、勿論、この気球に限定されるものでは無い。このオブジェクトの表示方法は、図３を用いて説明した実施例を使用することができる。勿論、この表示方法に限定されるものでは無い。

【００７２】次に、図１３を用いて、図１２中の１２－３に示した制御装置の内部構造を説明する。１３－１は電源ケーブルであり、これは、図１２に示した情報端末（１２－１）から供される。この電源ケーブルは、半導体レーザ、発光ダイオードに代表される光源（１３－２）、アバランシェフォトダイオード、光電子増倍管に代表される検出器（１３－３）、アナログディジタル変換器（１３－６）の制御用に使用する。また、光源及び検出器は光ファイバコネクタ（１３－４）を介して光ファイバに代表される光導波路（１３－５）に接続している。アバランシェフォトダイオード、光電子増倍管に代表された検出器（１３－３）は、光ファイバに代表される光導波路（１３－５）を伝搬した生体組織透過光強度を電気的信号へ変換し、そして、アナログ／ディジタル変換器（１３－６）にてディジタル化する。そして、信号伝送用ケーブル（１３－７）を用いて情報端末（１２－１）へ伝送する。

【００７３】以上述べた実施例では、精神状態を反映する生体内代謝物質濃度もしくはその濃度変化を光計測し、その計測結果を画面表示されたオブジェクトの位置情報へ反映させていた。このような反映方法以外にも、以下に示すような反映方法が考えられる。図１４は、脳活動に伴う血液量の変化（増加もしくは減少）を、画面上のオブジェクトのサイズを変化させることで表示する方法の実施例である。

【００７４】図１４において、１４－２は、基準となる血液量でのオブジェクトのサイズである。これ対して、１４－１、１４－３は、各々この基準となる血液量に対して、血液量が増加した場合、減少した場合のオブジェクトのサイズを示す。具体的なコンテンツとしては、画面上に表示されたオブジェクト（例えば、人体でも良いし、カエルのお腹でも良い）に対して、頭の中で、「大きくなれ」と念じることで脳内の血液量を増加することができれば、オブジェクトのサイズが大きくなる。一方、計測位置がずれていた場合、血液量が減少することも有り得る。その際は、オブジェクトのサイズが小さくなる。

【００７５】図１５は、脳活動に伴う血液量の変化（増加もしくは減少）を、画面上のオブジェクトの色（濃淡や種類）を変化させることで表示する方法の実施例である。１４－２は、基準となる血液量でのオブジェクトの色（例えば、赤）である。これ対して、１５－１、１５－３は、各々この基準となる血液量に対して、血液量が増加した場合、減少した場合のオブジェクトの色を示す。１５－１では、基準の色の赤が、血液量の増加に伴い真紅へ変化した場合、１５－２では、血液量の減少に伴い、ピンクへ変化した場合を示している。

【００７６】このほかにも、基準の赤色から、例えば血液量が増加した場合は青色、減少した場合は、黄色へ変化させることなども考えられる。具体的なコンテンツとしては、画面上に表示されたオブジェクト（信号機の赤が表示されている）に対して、頭の中で、「青くなれ！」と念じることで脳内の血液量を増加することができれば、オブジェクトの色が青くなるというものが考えられる。一方、血液量が減少した場合、オブジェクトの色が、別の色（例えば、黄色）へ変わることが考えられる。

【００７７】次に、被検査体に対して疲労を感じさせさせ難い遊戯装置の実施例（リミッター）を示す。図１６中の１６－１は、この実施例をフローチャートとして示している。このフローチャートに基づくアルゴリズムは、たとえば、１－８に示した電子計算機内に存在する記憶装置に保存されている。以下に、１６－１に示したフローチャートの概要を説明する。

【００７８】まず、ゲームを開始する（１６－２）。そして、まず、規定時間を設定し（１６－３）、記憶装置に保存する。この規定時間は、例えば３０分などと設定する。これは、ゲームを行うと一般にプレーヤーはのめり込むため、時の経つのを忘れがちになる。その結果、長時間ゲームをしてしまい、思わぬ疲労を感じるためである。この規定計測時間は、ゲームのコンテンツの種類や個人の肉体的な特徴に応じて任意に設定することが可能である。

【００７９】次に、サンプルタスクを実施する（１６－４）。これは、たとえば、「手を動かしてください」とか「今まで楽しかったことを思い出してください」とメッセージを被検査体へ提示し、被検査体上に配置した光照射器と光検出器を用いて生体内を通過し透過光の強度の変化を検出する。ここで安静時に対する検出光強度の変化をｘとし、これも記憶装置内に保存する（１６－５）。この記憶装置には更に、透過光強度の変化に関する閾値パラメータｋが設定されている。この閾値も、ゲームのコンテンツの種類や個人の肉体的な特徴に応じて任意に設定することが可能である。

【００８０】そして、メインのゲームを実行する。まず、ゲームが開始されてからの累積計測時間を求める。もし、この累積計測時間が規定計測時間（基準照射期間）内であれば、計測を継続し、否であれば、計測（ゲーム）を中断する（１６－６）。次に、透過光強度の変化を照査し（１６－７）、その強度が設定した閾値（ｘ×ｋ）より大きいか小さいかを判定する（１６－８）。透過光強度の変化が設定した閾値より小さい場合は、ゲ

ームを続行する（１６－９）。一方、閾値よりも大きい場合は、ゲームを中断する（１６－１０）。そして、中断した旨を、被検査体へ呈示し（１６－１１）、光源をＯＦＦする（１６－１２）。

【００８１】次に、透過光強度の変化を照査する方法を、以下の図１７を用いて説明する。まず、図１７（ａ）中の１７－１に示したように、或る時刻の間隔に応じて、検出光強度（透過光強度）を検査するためのトリガーが発せられる。このトリガーの発生間隔は、図に示したような等間隔に限らず、任意の間隔であっても何等問題がない。そして、このトリガーに対応して、電子計算機へ入力した生体組織透過光強度（検出光強度）をチェックする。

【００８２】図１７（ｂ）中の１７－２は、そのチェック方法の一実施例を示している。１７－３は生体組織透過光強度の時間依存性を示している。また、１７－４は、１７－１に示したトリガーが発せられたタイミングを１７－２上に重ねて表示している。更に、１７－５は或る所定の閾値強度を示している。この閾値強度は被検査体毎もしくは遊戯装置毎に任意の値に設定する。１７－２の場合、期間１７－６では、透過光強度は閾値強度を下回っている。

【００８３】次に、図１８を用いて、計測（ゲーム）を中断した旨を被検査体へ呈示する方法を説明する。図中の１８－１は、電子計算機であり、この電子計算機は、生体内組織伝播光強度に依存する脳活動を反映する遊戯装置を実現するために、表示用画面（１８－２）および音声呈示用スピーカー（１８－３）を具備している。図１６に示したように計測（ゲーム）を中断した旨を被検査体へ呈示するためには、第一に表示用画面（１８－２）上に「ゲーム終了」というメッセージを表示する。

【００８４】言い換えれば、ゲームを終了する旨のメッセージを画面上に呈示すること、画面の表示を通常のゲーム実施期間中とは変化させている。これと同様な方法で音声呈示用スピーカー（１８－３）から、計測を終了する旨、たとえば「ゲーム終了！」とメッセージが流れる。通常のゲーム中では、このスピーカーからゲームの臨場感を高めるために、効果音などが流れているが、このメッセージを流すことで、音声の呈示が通常のゲーム実施期間中とは変化させることが特徴である。

【００８５】

【発明の効果】以上述べた通り、本発明で提供する遊戯装置は、精神状態を反映する生体内代謝物質濃度もしくはその濃度変化を光計測し、その計測結果を画面表示されたオブジェクトにへ反映することが特徴である。この結果、マウス、ジョイスティック、ハンドルなどに代表される入力装置を用いることなく、画面上のオブジェクトを制御することが可能になる。この結果、新たな遊戯装置になり得る上、更に、手や足を使用することなく遊戯装置を楽しむことが可能になる。

【図面の簡単な説明】

【図１】生体光計測法に基づく遊戯装置の装置構成（１）を示す図。

【図２】脳の構造、生体内光伝搬特性、および脳活動に伴う生体内代謝物質の濃度増加のイメージを示す図。

【図３】脳活動期間の前後における生体内を伝搬した光の強度変化、及び、その強度変化を反映する画面上に表示されたオブジェクトの表示方法の実施例を説明する図。

【図４】生体光計測法に基づく遊戯装置の装置構成（２）－被検査体上の複数点計測法－を示す図。

【図５】図４に示した生体光計測法に基づく計測結果を用いた、画面上に表示されたオブジェクトの表示方法の実施例を説明する図。

【図６】生体光計測法に基づく遊戯装置の装置構成（３）－複数人被検査体の同時計測法（１）－を示す図。

【図７】生体光計測法に基づく遊戯装置の装置構成（４）－複数人被検査体の同時計測法（２）－を示す図。

【図８】図７に示した遊戯装置を実現する上での計測シーケンスを示す図。

【図９】図６、７に示した生体光計測法に基づく計測結果を用いた、画面上に表示されたオブジェクトの表示方法の実施例を説明する図。

【図１０】生体光計測法に基づく遊戯装置の装置構成（５）－複数人被検査体上の複数点同時計測法－を示す図。

【図１１】図１０に示した生体光計測法に基づく計測結果を用いた、画面上に表示されたオブジェクトの表示方法の実施例を説明する図。

【図１２】情報端末を用いた生体計測法、およびこの計測結果を用いた、画面上に表示されたオブジェクトの表示方法の実施例を説明する図。

【図１３】情報端末へ接続した生体計測装置の装置構成を示す図。

【図１４】画面上に表示したオブジェクトのサイズを変化させることで、脳活動に伴う血液量変化を被検査体へ呈示する実施例を説明する図。

【図１５】画面上に表示したオブジェクトの色彩を変化させることで、脳活動に伴う血液量変化を被検査体へ呈示する実施例を説明する図。

【図１６】被検査体に対して疲労を感じさせがたい遊戯装置の実施例（リミッター）に関するフローチャートを示す図。

【図１７】リミッターが計測（もしくはゲーム）の終了を判定するアルゴリズムの一実施例を説明ずる図。

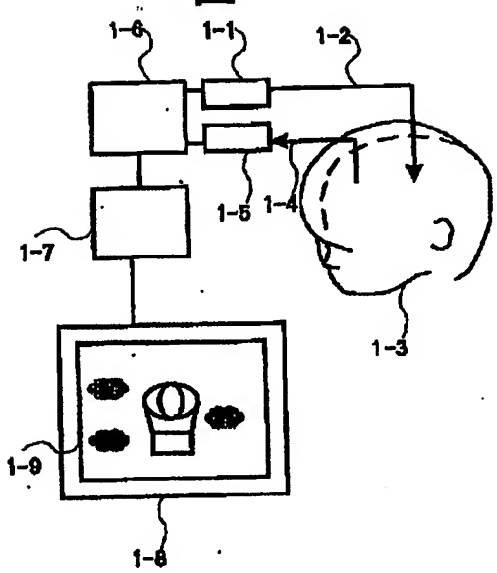
【図１８】ゲーム中断の実施方法の一例を説明する図。

【図１９】光生体計測法を用いた生体入力装置および生体制御装置を説明する図。

【符号の説明】
１－１:半導体レーザ、発光ダイオード、ランプに代表される光源、１－２：光導波路、１－３：被検査体、１－４：検出用の光ファイバ、１－５：光検出器、１－６：制御装置、１－７：アナログディジタル変換器、１－８：電子計算機、１－９：表示用画面２－１：光照射用光導波路、２－２：検出用光導波路。２－３：被検査体、２－４：頭蓋骨、２－５：脳脊髄液層、２－６：大脳皮質、２－７：大脳皮質内の血液量３－１：生体組織を透過した光の強度と計測時間の関係例、３－２：コンテンツの一実施例、３－３：気球、３－４：地面４－１：半導体レーザ、発光ダイオード、ランプに代表される光源、４－２：制御装置、４－３：光ファイバに代表される光導波路、光結合器：光結合器、４－５：複数の光ファイバに代表される光導波路、４－６：被検査体４－７：検出用の光ファイバに代表される光導波路、４－８：アバランシェホトダイオード、光電子増倍管に代表される光検出器、４－９：アナログデジタル変換器、４－１０：画面制御装置、４－１１：表示画面５－１：表示画面、５－２：川岸、５－３：カヌー、５－４：上流、５－５：下流、５－６：障害物６－１：半導体レーザ、発光ダイオード、ランプに代表される光源、６－２：制御装置、６－３：光ファイバに代表される光導波路、６－４：光結合器、６－５：複数の光ファイバに代表される光導波路、６－６：被検査体１、６－７：被検査体２、６－８：検出用の光ファイバに代表される光導波路、６－９：アバランシェホトダイオード、光電子増倍管に代表される光検出器、６－１０：アバランシェホトダイオード、光電子増倍管に代表される光検出器、６－１１：アナログデジタル変換器、６－１２：画面制御装置、７－１：半導体レーザ、発光ダイオード、ランプに代表される光源、７－２：制御装置、７－３：光ファイバに代表される光導波路、７－４：光結合器、７－５：複数の光ファイバに代表される光導波路、７－６：被検査体１、７－７：被検査体２、７－８：検出用の光ファイバに代表される光導波路、７－９：光結合器、７－１０：光ファイバに代表される光導波路、７－１１：アバランシェホトダイオード、光電子増倍管に代表される光検出器、７－１２：アナログデジタル変換器、７－１３：画面制御装置、７－１４：表示画面、７－１５：制御指令伝送用回路、８－１：制御装置（７－２）から光結合器（７－４）へ発せられる制御用パルス、８－２：照射用光ファイバ（７－５）を介して、被検査体１（７－６）へ照射される光強度、８－３：照射用光ファイバ（７－５）を介して、被検査体２（７－７）へ照射される光強度、８－４：検出用の光ファイバに代表される光導波路（７－８）により検出した被検査体１（７－６）の内部を伝搬した光の強度、８－５：検出用の光ファイバに代表される光導波路（７－８）により検出した被検査体２（７－７）の内部を伝搬した光の強度９－１：被検査体１、９－２：被検査体２、９－３：被検査体１の血液量変化（Ｂ１）と被検査体２の血液量変化（Ｂ２）の差を表示するインジケーター１０－１：半導体レーザ、発光ダイオード、ランプに代表される光源、１０－２：制御装置、１０－３：光ファイバに代表される光導波路、１０－４：被検査体１、１０－５：被検査体２、１０－６：検出用の光ファイバに代表される光導波路、１０－７：アバランシェホトダイオード、光電子増倍管に代表される光検出器、１０－８：アナログデジタル変換器、１０－９：画面制御装置、１０－１０：表示画面１１－１：表示画面、１１－２：川岸、１１－３：カヌー１、１１－４：カヌー２、１１－５：上流、１１－６：下流、１１－７：障害物、１１－８：時系列に推移した川の中でのカヌー１の位置、１１－９：時系列に推移した川の中でのカヌー１の位置、１２－１：情報端末、１２－２：表示画面、１２－３：光源及び検出器を具備することが特徴である制御装置、１２－４：照射用光ファイバ、１２－５：検出用光ファイバ、１２－６：被検査体、１２－７：脳活動を反映するオブジェクト１３－１：電源ケーブル、１３－２：半導体レーザ、発光ダイオードに代表される光源、１３－３：アバランシェフォトダイオード、光電子増倍管に代表される検出器、１３－４：光ファイバコネクタ、１３－５：光ファイバに代表される光導波路、１３－６：アナログ／ディジタル変換器、１３－７：信号伝送用ケーブル、１４－１：血液量が増加した場合のオブジェクト、１４－２：基準となる血液量でのオブジェクト、１４－３：血液量が減少した場合のオブジェクト、１５－１：血液量が増加した場合のオブジェクト、１５－２：基準となる血液量でのオブジェクト、１５－３：血液量が減少した場合のオブジェクト、１６－１：被検査体に対して疲労を感じさせがたい遊戯装置の実施例（リミッター）のフローチャート、１７－１：トリガー発生タイミング、１７－２：チェック方法の一実施例、１７－３：生体組織透過光強度の時間依存性、１７－４：トリガー発生タイミング、１７－５：或る敷居強度、１７－６：透過光強度は敷居強度を下回った期間、１８－１：電子計算機、１８－２：表示用画面、１８－３：音声呈示用スピーカー、１９－１：半導体レーザ、発光ダイオード、ランプに代表される光源、１９－２：照射用光ファイバに代表される光導波路、１９－３：被検査体、１９－４：光ファイバに代表される光導波路、１９－５：フォトダイオード、光電子増倍管に代表される光電素子、１９－６：電子計算機。

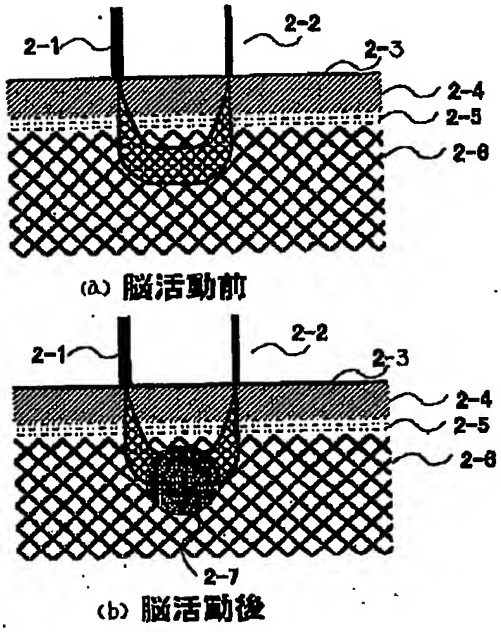
【図１】

図1



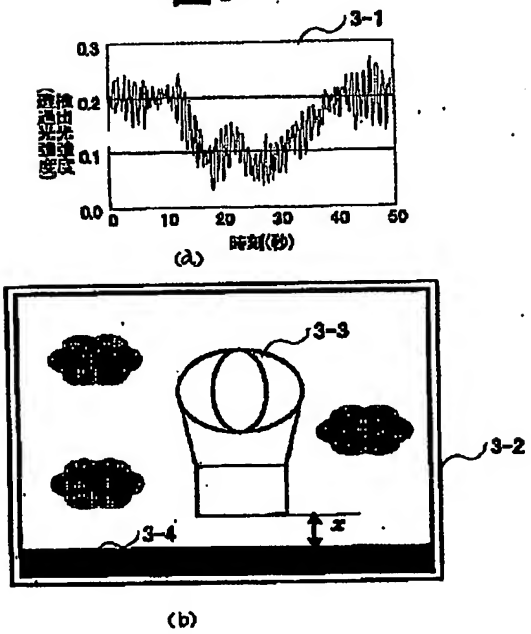
【図２】

図2



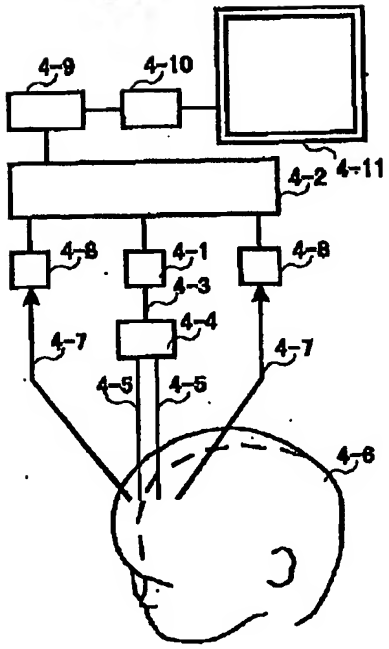
【図３】

図3



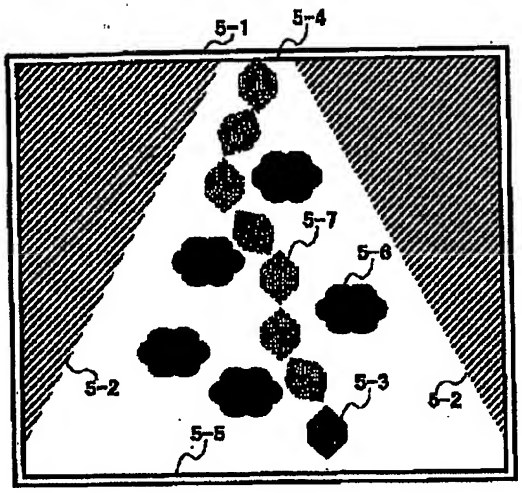
【図４】

図4



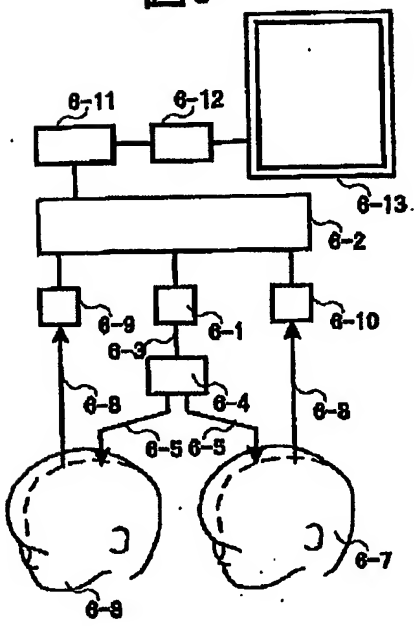
【図5】

図5



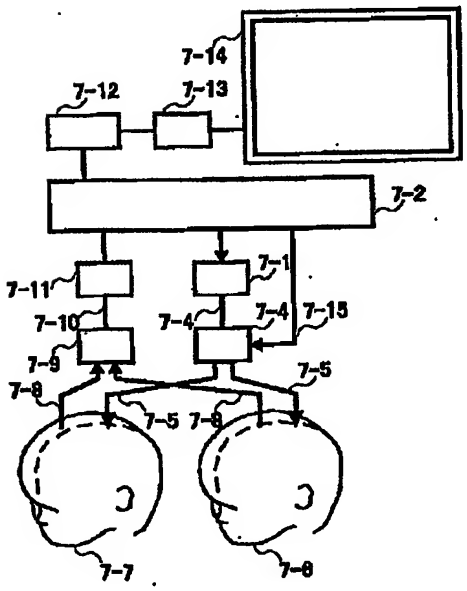
【図6】

図6



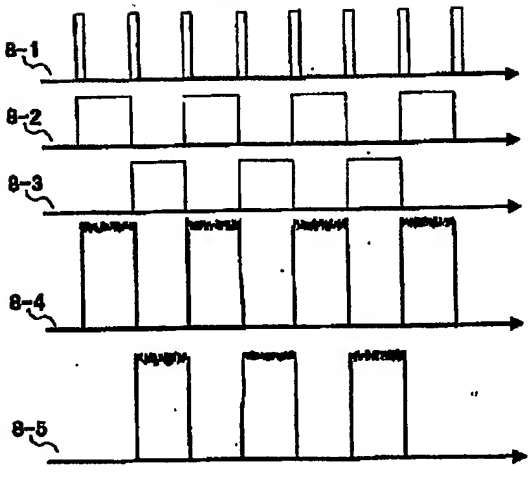
【図7】

図7



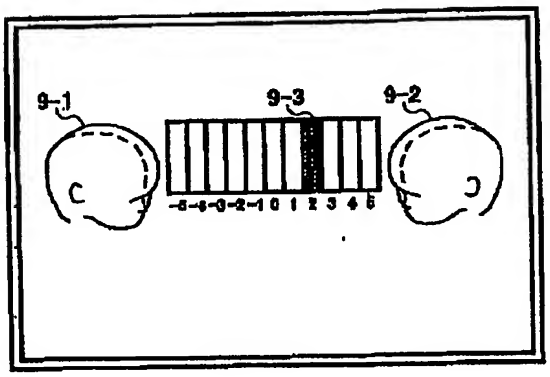
【図8】

図8



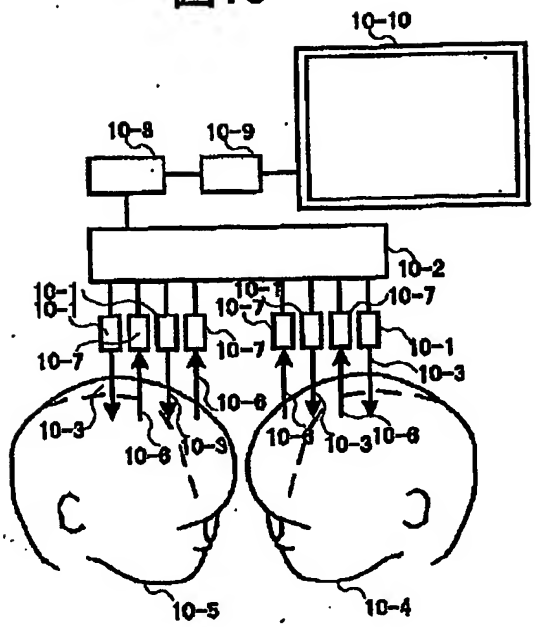
【図９】

図9



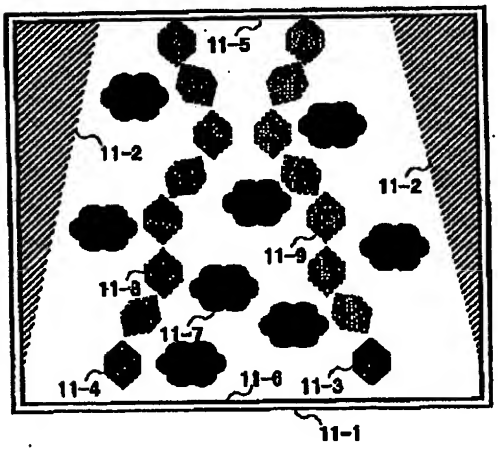
【図１０】

図10



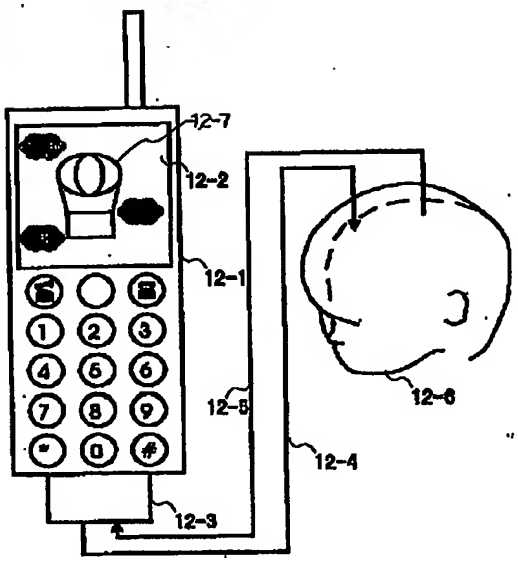
【図１１】

図11



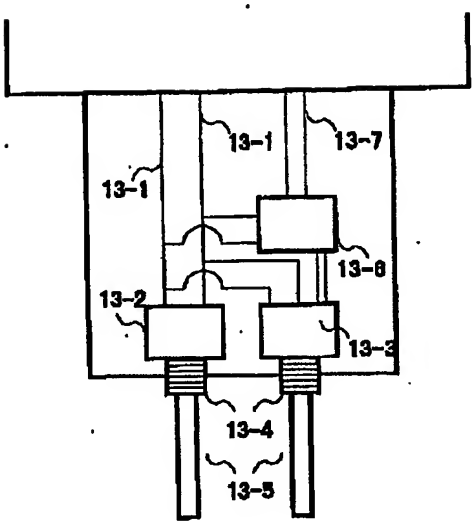
【図１２】

図12



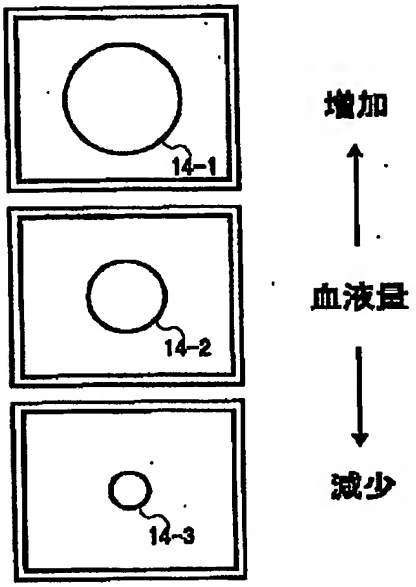
【図１３】

図13



【図１４】

図14



【図１５】

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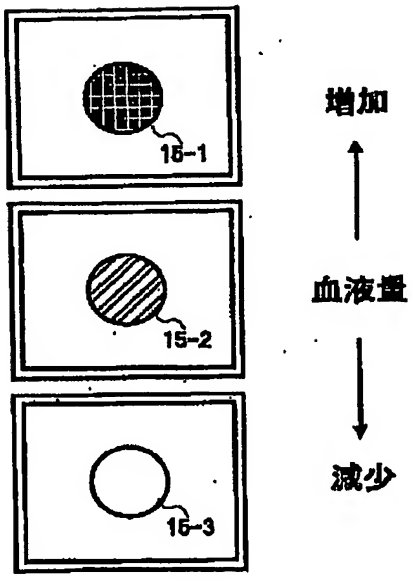

【図１６】

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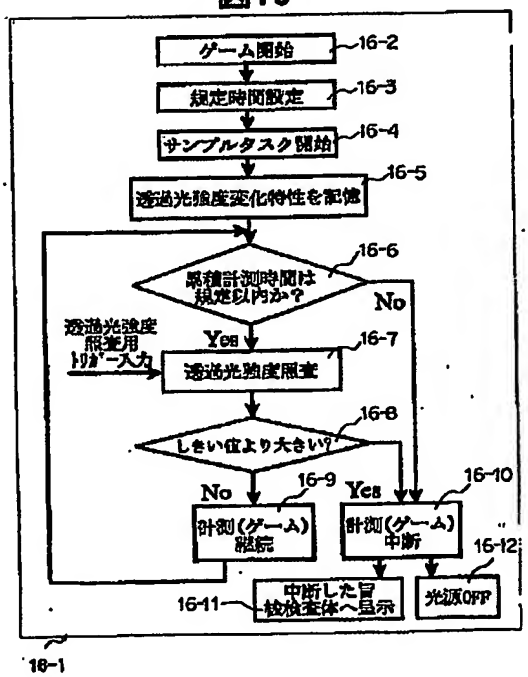
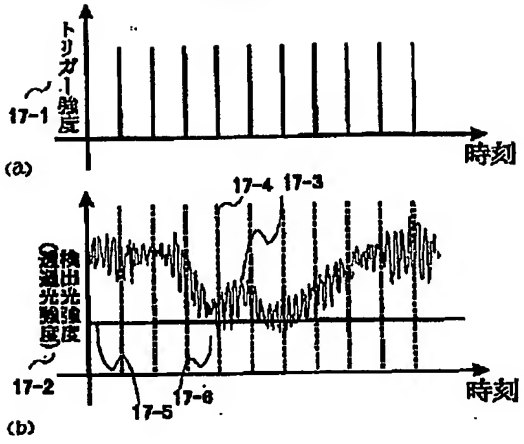


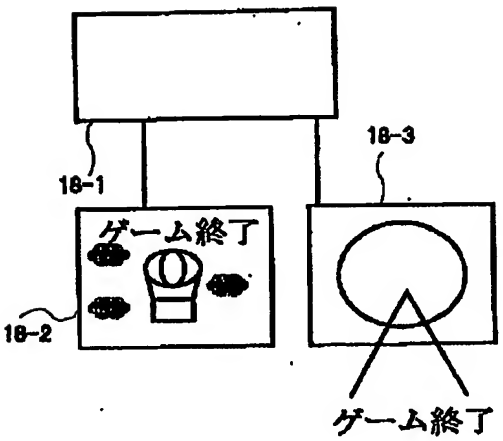
【図１７】

図17



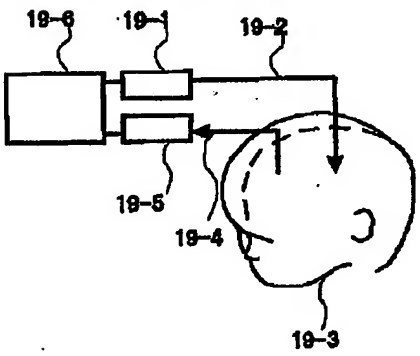
【図１８】

図18



【図１９】

図19



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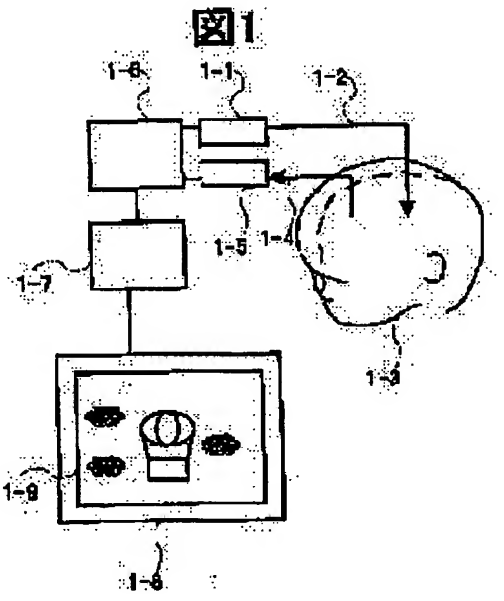
(54) GAME MACHINE USING METHOD FOR MEASURING BIOLOGICAL LIGHT

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a game machine which measures the density of a metabolite in a living body reflecting a mental state and brain activity and the change in optical intensity transmitted through the living body reflecting the change of the density and reflects the result in measurement to an object displayed on a screen.
SOLUTION: By bringing optical illuminators (1-1), (1-2) and a photodetector (1-5) into contact with the skin of a patient (1-3), the optical intensity propagated through the inside of the patient is detected and the result in detection is sent to a computer (1-8). Then, in accordance with the change in the detected optical intensity, the position, shape and color of the object displayed on the screen (1-9) are changed. It is possible to control the state of the object on the screen directly by measuring what is thought by a person without using an existent input device represented by a mouse, a joy stick, a handle, or the like.

図1



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CLAIMS

[Claim(s)]
[Claim 1] At least one optical exposure machine for irradiating light at a living body, and at least one photodetector for condensing the passage light which it irradiated from said optical exposure machine, and spread in the living body [said], The display equipped with the display screen which displays at least one object, It has the operation part which controls said display based on the measurement signal about said passage luminous intensity measured with said photodetector. And play equipment using the living body light mensuration characterized by constituting so that the condition that said at least one object displayed on said display screen is included according to a change of the measurement signal measured by said at least one photodetector on the strength may change.
[Claim 2] At least one optical exposure machine for irradiating light at two or more living bodies, and at least one photodetector for condensing the passage light which it irradiated from said optical exposure machine, and spread in the living body [said], The operation part equipped with the display screen which displays at least one object, It has the operation part which controls said display based on the measurement signal about said passage luminous intensity measured with said photodetector. And play equipment using the living body light mensuration characterized by constituting so that the condition that one or more objects displayed on said display screen are included according to a change of the measurement signal measured by said at least one photodetector on the strength may change.
[Claim 3] At least one optical exposure machine for irradiating light through waveguide at two or more living bodies' each, At least one photodetector for condensing the passage light which it irradiated from this optical exposure machine, and spread in the living body [said], The display equipped with the display screen which displays at least one object, It has the operation part which controls said display based on the measurement signal about said passage luminous intensity measured with said photodetector. And play equipment using the living body light mensuration characterized by constituting so that the condition that one or more objects displayed on said display screen are included according to a change of the measurement signal measured by said at least one photodetector on the strength may change.
[Claim 4] It is play equipment using claims 1 and 2 characterized by constituting so that said optical exposure machine, said photodetector, said storage, and said computer may be made to build in an information terminal and some of said optical exposure machines and said photodetectors may be combined with the terminal of said information terminal, or living body light mensuration given in three.
[Claim 5] Said operation part comes to contain the function to memorize the accumulation time amount and the criteria exposure period which irradiated light from said optical exposure machine, and the loudspeaker which utters voice. And when the accumulation time amount which irradiated light from said optical exposure machine exceeds said criteria exposure period the command which makes the configuration on said display screen change — or the play equipment using claims 1 and 2 characterized by constituting so that the command which makes the voice uttered from said loudspeaker change may be issued, or living body light mensuration given in three.

[Claim 6] Said operation part is play equipment using the living body light mensuration according to claim 5 characterized by to constitute so that the command which makes the voice which is made to change the configuration on said display screen, or is uttered from said loudspeaker change may be issued, when the reinforcement of said transmitted light exceeds a predetermined threshold, even if the accumulation time amount which irradiated light from said optical exposure machine is within said criteria exposure period.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to play equipment and relates to the play equipment using the living body light mensuration which measures change of the optical reinforcement which penetrated in the living body reflecting the metabolite concentration in the living body which reflects a mental condition and a brain activity especially, or its concentration change.
[0002]
[Description of the Prior Art] A computer, a game, an environment control unit, the living body input unit using the Mitsuo object mensuration which controls judgment equipment, the alarm of a vehicle, a medical-application diagnosis and an alarm, the lie detector, declaration-of-intention equipment, a data transmission unit, etc. whenever [study], and biological control equipment are proposed in JP,9-149894,A by measuring the localized cerebral function and inputting into an external device. Hereafter, this is explained using drawing 19 .
[0003] In order to irradiate light to an inspected object, the light source (19-1) represented by semiconductor laser, a light emitting diode, and the lamp and the optical waveguide (19-2) (the above is named generically and it considers as an optical exposure machine) represented by the optical fiber for an exposure are used. Although it is optimal that the permeability of a body tissue uses light with a high wavelength of about 800 nanometers as for the wavelength of the light used for measurement, it is not limited to this wavelength range.
[0004] The both ends of optical waveguide touch, respectively on the skin of the light source (19-1) and an inspected object (19-3). The light irradiated to the living body is strongly scattered about by the body tissue. However, a part of the scattered light passes the cerebral cortex which the higher brain function represented by movement, feeling, and language concentrates, and it reaches again to the scalp which separated about 30 millimeters (in the case of an adult) from the optical exposure location.
[0005] A photodetector is arranged in order to detect the luminous intensity which spread in the living body in this location. This photodetector consists of the photodiodes and the photoelectric elements (19-5) represented by the photomultiplier tube which contacted that end to the optical waveguide (19-4) represented by the optical fiber. It is changed into an electric signal from an optical signal using this photodetector. And this electric signal is processed using a computer (19-6).
[0006] Here, it is assumed that it made the brain work by moving the bodies (a hand, guide pegs, these fingers, etc.), considering an object, or praying. If a brain works, in order to supply oxygen and a glucose to a cerebral activity part, the blood volume in the cerebral cortex changes by increasing or decreasing secondarily. If near-infrared light (wavelength of about 800 nanometers) is used for measurement, in order that the hemoglobin in blood (an oxyhemoglobin, reduced hemoglobin) may absorb this light used for measurement, the quantity of light which reached to the optical fiber for detection will decrease, if the amount of hemoglobin increases with a brain activity. For this reason, change of the detected luminous intensity reflects a cerebral activity. This luminous-intensity change is measured and the input unit which measures thinking of the

Homo sapiens reflecting a mental condition or a brain activity, and controls a computer by controlling a computer using this measurement result is realized.
[0007]
[Problem(s) to be Solved by the Invention] Two technical problems shown below are solved in this invention.
[0008] The play equipment which used the above-mentioned living body light metering device for the 1st is realized. Generally, play equipment possesses the input device represented by a mouse, a joy stick, a handle, the touch panel, etc., and the Braun-tube display, the liquid crystal display and the presentation equipment represented by the light emitting diode array that whose the input result is shown to a player it is the description. These existing input units move a hand and a guide peg based on the command from a brain, and inputting the command from a brain into a computer using these hands or a guide peg is mentioned as a common feature. Various play equipments are already realized because the location of the object displayed on presentation equipment, a gestalt, and the "condition" of being represented by size change according to this input.
[0009] On the other hand, although it is possible to input into a computer as it is that Homo sapiens considers the living body input unit indicated in JP,9-149894,A not using a hand or a guide peg, the operation means of the concrete play equipment using this living body input unit is not indicated at all. If play equipment is realized concretely, it will enable various persons for it to be able to become play equipment new also for a difficult person to move not only a healthy person but a hand and a guide peg, consequently to enjoy itself using the same play equipment.
[0010] So, in this invention, the command from a brain and a cerebral activity are inputted into a direct computer using optical cerebral function mensuration, and it sets it as the 1st purpose to realize the play equipment based on the input result.
[0011] The Homo sapiens cerebral function activated when Homo sapiens is going to consider an object, pray an object or specifically move a hand and a guide peg in the first place is measured using light. The play equipment which makes it possible to reflect the measurement result of an activity of this Homo sapiens cerebral function in the second to the object displayed on the screen of a computer is realized.
[0012] It sets it as the 2nd purpose to offer the contents of the game in which fatigue is not impressed because a player focuses [2nd] on a game too much in the above-mentioned play equipment by this invention.
[0013] Above play equipment controls a computer using the human brain activity. Since in other words the human brain activity is controlled using the head, it may get fatigued in order to use the head. Moreover, when the contents of the created game are interesting for a player, he forgets for time amount to pass, it is absorbed in a game, and, as a result, fatigue may be sensed. Then, the example of the game in which fatigue is not impressed such is offered.
[0014]
[Means for Solving the Problem] Measurement field division of the human brain is carried out like by different cytoarchitecture expressed by Broadmann's atlas of brain. Furthermore, each of these fields share a different function. For example, if a brain is seen from width, the field where the field which participates in spontaneous movements (a hand, a guide peg, finger, etc.) participates in the summit section, feeling, and vision will share the field about the regio occipitalis capitis and language with the predetermined section of a left half.
[0015] In this invention, in order to extract the information from the location pinpointed in this way with high degree of accuracy, living body light mensuration with high spatial resolving power is used (in measurement of an electroencephalogram, since the dielectric constant in a living body is uneven, the source location of a signal becomes indefinite, and spatial resolving power is low.). Moreover, since myoelectric potential is greatly reflected in a signal to a motion of a test subject's body, there is also a difficulty of restraining a test subject.
[0016] This living body light mensuration by irradiating the inspected body skin skin on the skin of an unit or two or more inspected objects from at least one optical exposure machine and this optical exposure machine At least one photodetector arranged on the inspected body skin skin for condensing the passage light inside this inspected body skin skin, and measuring this

condensed inspected object passage light reinforcement, It consists of operation part which calculates concentration change of the metabolite in the living body measured using these light exposure machine and the photodetector.
[0017] And with the play equipment based on this invention, it is the description that the operation part of this living body light mensuration has connected with the display possessing the display screen. And at least one existing object is displayed on the display screen in this display. It is the description that the location of this object, a gestalt, and the "condition" of being represented by size change according to signal luminous-intensity change which penetrated in the living body. It becomes possible to visualize concentration change of the metabolite in the living body accompanying a brain activity by this. Consequently, an inspected object is making one's brain work, it becomes possible to change the location of the object displayed on the screen, a gestalt, and the "condition" of being represented by size, and the play equipment which this invention makes the purpose can be realized. In addition, even if operation part and the display screen are one, they may be the configuration of having become independent.
[0018] Thus, at least one optical exposure machine for this invention to irradiate light at a living body, At least one photodetector for condensing the passage light which it irradiated from said optical exposure machine, and spread in the living body [said], The display equipped with the display screen which displays at least one object, It has the operation part which controls said display based on the measurement signal about said passage luminous intensity measured with said photodetector. And the play equipment using the living body light mensuration characterized by constituting so that the condition that said at least one object displayed on said display screen is included according to a change of the measurement signal measured by said at least one photodetector on the strength may change is offered.
[0019] Moreover, at least one optical exposure machine for this invention to irradiate light at two or more living bodies, At least one photodetector for condensing the passage light which it irradiated from said optical exposure machine, and spread in the living body [said], The operation part equipped with the display screen which displays at least one object, It has the operation part which controls said display based on the measurement signal about said passage luminous intensity measured with said photodetector. And the play equipment using the living body light mensuration characterized by constituting so that the condition that one or more objects displayed on said display screen are included according to a change of the measurement signal measured by said at least one photodetector on the strength may change is offered.
[0020] Moreover, at least one optical exposure machine for this invention to irradiate light through waveguide at two or more living bodies' each, At least one photodetector for condensing the passage light which it irradiated from this optical exposure machine, and spread in the living body [said], The display equipped with the display screen which displays at least one object, It has the operation part which controls said display based on the measurement signal about said passage luminous intensity measured with said photodetector. And the play equipment using the living body light mensuration characterized by constituting so that the condition that one or more objects displayed on said display screen are included according to a change of the measurement signal measured by said at least one photodetector on the strength may change is offered.
[0021] Moreover, the play equipment using the living body light mensuration characterized by constituting so that this invention may make an optical exposure machine, a photodetector, a display, and operation part build in the same information terminal in said configuration and some of optical exposure machines and photodetectors may be combined with the terminal of said information terminal is offered.
[0022] This invention is set in said configuration. Furthermore, operation part It comes to contain the function to memorize the accumulation time amount and the criteria exposure period which irradiated light from the optical exposure machine, and the loudspeaker which utters voice. and the command into which the configuration on the display screen is made to change when the accumulation time amount which irradiated light from the optical exposure machine exceeds a criteria exposure period — or the play equipment using the living body light mensuration

characterized by constituting so that the command which makes the voice uttered from a loudspeaker change may be issued is offered.
[0023] The play equipment using the living body light mensuration characterized by to constitute this invention further again so that the command which makes the voice which is made to change the configuration on the display screen , or is uttered from a loudspeaker change may issue , when the reinforcement of the transmitted light exceeds a predetermined threshold , even if the accumulation time amount to which operation part irradiated light from the optical exposure machine in said configuration is within said criteria exposure period offers .
[0024]
[Embodiment of the Invention] In this invention, the activity situation of the cerebral function localized using light is measured, and the measured signal is used as an input signal of operation part, such as a computer. One or more optical exposure machines and one or more photodetectors are contacted on the skin of one or more persons' inspected object, and, specifically, luminous-intensity change which penetrated in the living body is measured. This measurement result reflects concentration change of the metabolites (an oxyhemoglobin, reduced hemoglobin, etc.) in the living body accompanying a brain activity. This measurement result is used as an input signal to operation part. The display (presentation) screen to an inspected object exists in the display connected to operation part, and one or more objects exist on the screen. According to change (or luminous-intensity change which penetrated in the living body) of the input signal reinforcement to the operation part reflecting the concentration of a metabolite in the living body, concentration change, i.e., this concentration, or concentration change, the gestalten (a location, color, size, etc.) of one or more objects change.
[0025] That is, a cerebral function is measured using light and the play equipment from which the condition of the object on the display screen connected to operation part, such as a computer, according to the active state of a cerebral function changes can be realized.
[0026] Hereafter, the example about this invention is concretely explained using drawing.
[0027] One Mitsuteru gunner stage and one photodetection means are used for drawing 1 on one player , it measures the concentration of metabolites (for example , the oxyhemoglobin in blood , the reduced hemoglobin , a cytochrome , etc.) in the living body , or its concentration change , and shows one example which realizes the play equipment reflecting the brain activity depending on organization propagation light reinforcement in the living body to the object displayed on the screen . 1-1 is the light source represented by semiconductor laser, light emitting diode, and the lamp, and the tip is connected with optical waveguide (for example, optical fiber) 1-2.
[0028] that of an optical fiber is also obtained and the end touches on the skin of an inspected object (1-3) (for example, scalp on). the scalp — the case where it contacts upwards — the scalp — the hair of the hair which exists upwards — pushing aside — the scalp — it is desirable for the tip of direct optical waveguide to touch upwards. Because, when the light used for measurement is absorbed by the hair of hair, it is for optical exposure effectiveness to fall.
[0029] 1-4 — optical waveguide (1-2) — it is the optical fiber for detection used in order to detect the light which it therefore irradiated and spread the interior of an inspection object (103). The end of this optical fiber (1-4) touches on the skin of an inspected object (1-3) (for example, scalp on). a reason with the same said of the end of this optical fiber — the scalp — the hair of the hair which exists upwards — pushing aside — the scalp — it is desirable for the tip of direct optical waveguide to touch upwards. Moreover, the end is already connected to the photodetector (1-5) represented by an avalanche photo-diode and the photomultiplier tube. These light sources (1-1) and a photodetector (1-5) are electrically connected with the control unit (1-6). This control device (1-6) is connected with the operation part (1-8) represented by the computer etc. through an analog-to-digital converter (1-7).
[0030] Transmission of bidirectional information is possible for this control unit (1-6) and operation part (1-8) to mutual. A control unit (1-6) can adjust the quantity of light to the light source (for example, the luminescence reinforcement of the light source which generates the light source of the shape of ON of the light source or OFF, and a pulse is modulated with a certain angular frequency).
[0031] Moreover, operation part (1-8) possesses the store (for example, a hard disk, memory), in

order to store temporarily or eternally the information on detected luminous-intensity change (time-of-day dependency). The optical analog reinforcement which reached the photodetector (1-5) is changed into digital optical reinforcement through an analog-to-digital converter (1-7), and the result is transmitted to operation part (1-8).

[0032] Moreover, the signal which directs quantity of light adjustment of the light source is transmitted to a control unit (1-6) from operation part (1-8). In this example, although a control device (1-6), analog-to-digital-conversion equipment (1-7), and operation part (1-8) have separate isolated-system composition, even if they are the unified equipment configuration, they are satisfactory in any way.

[0033] Moreover, in order to realize the play equipment which reflects the brain activity depending on organization propagation light reinforcement in the living body on a computer (1-8) to the object displayed on the screen, it has the display equipped with the display screen (1-9). The configuration of this display screen (1-9) is explained using another example. In addition, operation part may really be a configuration or this display may be a separate isolated-system configuration.

[0034] Next, how to measure change of metabolite concentration in the living body is explained using the measurement approach shown in drawing 2 .

[0035] first, the measurement approach shown in drawing 2 — using — the optical waveguide for an optical exposure (2-1), and the optical waveguide for detection — (2-2) — the scalp of an inspected object (2-3) — it is made to contact upwards As for a human brain, a skull (2-4), a cerebrospinal fluid layer (2-5), the cerebral cortex (2-6), etc. exist in the shape of a layer inside the scalp. here, as for the optical waveguide for an optical exposure (2-1), and the optical waveguide for detection (2-2), an inspected object (2-3) does not sense a pain — like — the scalp — it is made to contact lightly upwards

[0036] Here, body tissues are strongly scattered about in light. For this reason, a part of scattered light reaches via the cerebral cortex (2-6) which exists inside a skull (2-4) and the higher brain function of a Homo sapiens proper is concentrating to the contact location of the scalp of the optical waveguide for detection (2-2), and an inspected object (2-3), as shown in drawing 2 (a). In the adult, generally, this attainment location is separated from the optical exposure location (scalp of the optical waveguide for an optical exposure (2-1) upper contact location) about 30mm.

[0037] Here, in order to supply oxygen and a glucose to the activity part of a cranial nerve cell as shown in drawing 2 (b) if a brain works, the blood volume in the cerebral cortex (oxyhemoglobin concentration, reduction hemoglobin concentration) changes (2-7). It is most desirable for body tissue permeability to use for measurement the near-infrared light (wavelength: before or after 800 nanometers) absorbed highly (water and protein in a living body being hard to be measured) by the hemoglobin in blood (an oxyhemoglobin, reduced hemoglobin). Of course, there is nothing what is limited to the light of this wavelength object. Here, if the blood volume of the cerebral cortex increases because a brain works (reduction), the luminous intensity detected will decrease (increment).

[0038] Next, one example of the contents of the play equipment reflecting the brain activity (nerve activity) depending on organization propagation light reinforcement in the living body is shown to the object displayed on the screen using the instrumentation system shown in drawing 1 .

[0039] First, the related example of luminous intensity and measurement time amount which penetrated the body tissue to 3-1 in drawing 3 (a) is shown. In this measurement, the optical fiber for an optical exposure and the optical fiber for photodetection which were shown in drawing 1 have been arranged at intervals of 30mm on 1-centimeter left eyebrow hair top the "frame" of a certain inspected object. During the measurement period in this drawing (50 seconds), in 10 to 30 seconds (for 20 seconds), an inspected object is 1Hz about that right hand, and repeated "it is good" and a "par." On the other hand, in such time amount, the inspected object took the rest condition. After detection light reinforcement decreases after [of an after / task initiation] several seconds and a task is completed from this measurement result, it turns out that detection light reinforcement is increasing. This corresponds with metabolite

concentration (hemoglobin concentration) in the living body increasing by cerebral activity.
[0040] Then, one example of contents as shown in 3-2 in drawing 3 (b) is offered. From these contents, a balloon (3-3) exists on a screen. This balloon exists in the location of height x to the ground (3-4).
[0041] The decision approach of this height x will be determined as follows, if the related example (3-1) of luminous intensity and measurement time amount which penetrated the body tissue is imitated. Whether it is the average in this period even if it is a certain criteria reinforcement and is the reinforcement in the arbitration time of day in a measurement period (during a play equipment operation period), or the detection light reinforcement of t= 0 in a formula (1) is the criteria reinforcement determined as arbitration in addition to this, it is not cared about. Of course, there is nothing what is limited to the decision approach using this formula (1).
[0042]
x=ln {(detection light reinforcement of t= 0) /(detection light reinforcement in time of day t)} ..... Formula (1)
According to this formula (1), if transmitted light reinforcement decreases, x will increase, and on the other hand, if transmitted light reinforcement increases, x will decrease. For this reason, when a brain works, it turns out that the height of a balloon becomes high. It was activated, when Homo sapiens was going to consider an object in the first place by using the above approach, an object tended to be prayed or it was going to move a hand and a guide peg, and the Homo sapiens cerebral function which is invisible was able to be measured, that result was able to be inputted into the direct computer the second, and the play equipment from which the object displayed on the third on the screen according to the brain activity when visualizing and putting in another way this Homo sapiens cerebral function changes was able to be realized.
[0043] The modification of the example described above is described below.
[0044] Drawing 4 sets up two or more measure points on the skin of an inspected object, and measures concentration change of the matter concentration in a metabolic turnover in these two or more measure points. And based on the measurement result of these concentration change, the example which realizes the play equipment reflecting the brain activity depending on organization propagation light reinforcement in the living body is described to the object displayed on the screen. 4-1 is the light source represented by semiconductor laser, light emitting diode, and the lamp. This luminescence reinforcement was controlled by the control unit (4-2), and 4-1 and 4-2 are combined electrically.
[0045] The end which is represented by semiconductor laser, a light emitting diode, and the lamp and which will be accepted the light source (4-1) was connected to the optical waveguide (4-3) represented by the optical fiber, and this optical fiber is further connected to the optical waveguide for an exposure (4-5) represented by two or more optical fibers with an optical coupling vessel (4-4). The tip of the optical fiber of these plurality touches on two or more [on the skin of an inspected object (4-6)]. For example, it is possible to arrange to a temporal lobe on either side, respectively. Of course, you may arrange at the point of the arbitration on not the thing limited to this configuration method but the skin of an inspected object. In the location several centimeters away from the tip of the optical waveguide for an exposure (4-5) represented by each optical fiber, the optical waveguide (4-7) represented by the optical fiber for detection is arranged. For example, although it is desirable to make it about 3 centimeters if the candidate for measurement is concentration change (blood volume change) of the metabolite in the living body accompanying the activity of a Homo sapiens cerebral function, of course, there is nothing what is limited to this value.
[0046] The end which is represented by the optical fiber for this detection and which will be accepted optical waveguide (4-7) is connected to the photodetector (4-8) represented by an avalanche photo-diode and the photomultiplier tube. The luminous intensity which spread in the living body is changed into electric signal strength by this photodetector (4-8). And it is inputted into the control unit (4-2) combined electrically. This signal strength inputted into the control device (4-2) is inputted into an analog-to-digital converter (4-9), and that digital signal is inputted into operation part (screen control equipment) (4-10). In this example, this screen

control equipment (4-10) possesses the display screen (4-11). The contents displayed on the display screen mention later. If the measurement approach described above is used, the play equipment reflecting the brain activity depending on organization propagation light reinforcement in the living body is realizable to the object displayed on the screen described below.
[0047] the optical waveguide for an exposure (4-5) represented by the optical fiber shown in drawing 4 — the scalp — it is arranged at two or more upper points. The Homo sapiens cerebral function is localized on the cerebral cortex for every function. For example, if one of this optical waveguide is installed on a left temporal lobe and one more is installed on a right temporal lobe, it will become possible to measure the brain activity of the right finger motor area and the **** motor area, respectively. moving a right finger, if it has another way of speaking — a left temporal lobe — being activable — consequently, the scalp of an inspected object (4-6) — it becomes possible to measure activation of the brain in a left temporal lobe using the optical waveguide for an exposure (4-5) installed upwards, and the optical waveguide (4-7) represented by the optical fiber for detection. similarly moving a left finger — a right temporal lobe — being activable — consequently, the scalp of an inspected object (4-6) — it becomes possible to measure activation of the brain in a right temporal lobe using the optical waveguide for an exposure (4-5) installed upwards, and the optical waveguide (4-7) represented by the optical fiber for detection. Thus, it becomes possible by installing two or more measure points to measure two or more kinds of brain activities.
[0048] Then, drawing 5 explains how to realize the play equipment reflecting the brain activity depending on organization propagation light reinforcement in the living body, to the object displayed on a display screen (4-11). 5-1 is the display screen and is expressing river going down which used the canoe in this display screen. 5-2 is Kawagishi and a canoe (5-3) navigates the inside of the river surrounded by Kawagishi. This canoe navigates from the upstream (5-4) to a lower stream of a river (5-5) according to the rate of flow for every point beforehand memorized on the computer.
[0049] 5-6 in drawing 5 is an obstruction, and when a canoe (5-4) contacts this obstruction, a canoe stops navigating. The obstruction stated to 5-6 assumes a rock, driftwood, etc. which exist in a river, and there is what is limited to the configuration of the obstruction displayed into drawing 5 . [no] The canoe (5-7) of the broken-line configuration shown in drawing 5 is the location of the canoe in the inside of the river which changed to time series, and it is advancing the inside of a river, without contacting an obstruction (5-6). Thus, what is necessary is just to activate independently the finger motor area which exists in a temporal lobe on either side by making a finger on either side exercise, in order to progress the inside of a river.
[0050] Consequently, the play equipment reflecting the brain activity depending on organization propagation light reinforcement in the living body is realizable to the object (in the case of drawing 5 canoe (5-3)) displayed on the screen.
[0051] There is the outstanding description which is not in the cerebral function mensuration (for example, functional MAG drawing equipment) which used the MAG, the cerebral function mensuration (for example, electroencephalograph) using the electrical and electric equipment, and the cerebral function mensuration (for example, positive electron exposure tomogram drawing equipment) using a radiation in the cerebral function mensuration using the light described above. It is that it is possible to measure the localized Homo sapiens cerebral function safely, even if equipment is small. For this reason, it is also possible to measure two or more Homo sapiens cerebral function to coincidence. Then, it explains using the example which realizes the play equipment reflecting the brain activity depending on organization propagation light reinforcement in the living body to the object which measured two or more Homo sapiens cerebral function to coincidence, consequently was displayed on the screen.
[0052] Drawing 6 is one gestalt of the example in the case of carrying out coincidence measurement of two or more inspected objects. 6-1 is the light source represented by semiconductor laser, light emitting diode, and the lamp. This luminescence reinforcement was controlled by the control unit (6-2), and 6-1 and 6-2 are combined electrically. The end which is represented by semiconductor laser, a light emitting diode, and the lamp and which will be accepted the light source (6-1) was connected to the optical waveguide (6-3) represented by

the optical fiber, and this optical fiber is further connected to the optical waveguide (6-5) represented by two or more optical fibers with an optical coupling vessel (6-4). The tip of the optical fiber of these plurality touches respectively on the skin of the inspected object 1 (6-6) and the inspected object 2 (6-7).

[0053] In the location several centimeters away from the tip of the optical waveguide for an exposure (6-5) represented by each optical fiber, the optical waveguide (6-8) represented by the optical fiber for detection is arranged. For example, although it is desirable to make it about 3 centimeters if the candidate for measurement is concentration change (blood volume change) of the metabolite in the living body accompanying the activity of a Homo sapiens cerebral function, there is nothing what is limited to this value, of course.

[0054] The end which is represented by the optical fiber for this detection and which will be accepted optical waveguide (6-8) is connected to the photodetector (6-9 and 6-10) represented by an avalanche photo-diode and the photomultiplier tube. The luminous intensity which spread in the living body is changed into electric signal strength by this photodetector. And it is inputted into the control unit (6-2) combined electrically. This signal strength inputted into the control device is inputted into an analog-to-digital converter (6-11), and that digital signal is inputted into screen control equipment (6-12). This screen control equipment possesses the display screen (6-13). The contents displayed on the display screen mention later.

[0055] By the measurement approach described above, the photodetector (6-9 and 6-10) represented by an avalanche photo-diode and the photomultiplier tube became two or more place important point. Then, in the following examples, drawing 7 explains the mensuration which can measure two or more inspected objects to coincidence with the number of fewer detectors. 7-1 is the light source represented by semiconductor laser, light emitting diode, and the lamp. This luminescence reinforcement was controlled by the control unit (7-2), and 7-1 and 7-2 are combined electrically.

[0056] The end which is represented by semiconductor laser, a light emitting diode, and the lamp and which will be accepted the light source (7-1) was connected to the optical waveguide (7-3) represented by the optical fiber, and this optical fiber is further connected to the optical waveguide (7-5) represented by two or more optical fibers with an optical coupling vessel (7-4). The tip of the optical fiber of these plurality touches respectively on the skin of the inspected object 1 (7-6) and the inspected object 2 (7-7).

[0057] In the location several centimeters away from the tip of the optical waveguide for an exposure (7-5) represented by each optical fiber, the optical waveguide (7-8) represented by the optical fiber for detection is arranged. For example, although it is desirable to make it about 3 centimeters if the candidate for measurement is concentration change (blood volume change) of the metabolite in the living body accompanying the activity of a Homo sapiens cerebral function, there is nothing what is limited to this value, of course. The end which is represented by the optical fiber for this detection and which will be accepted optical waveguide (7-8) is combined with the optical coupling machine (7-9).

[0058] The output from this optical coupling machine is connected to the photodetector (7-11) represented by an avalanche photo-diode and the photomultiplier tube through the optical waveguide (7-10) represented by the optical fiber. The luminous intensity which spread in the living body is changed into electric signal strength by this photodetector. And it is inputted into the control unit (7-2) combined electrically. This signal strength inputted into the control device is inputted into an analog-to-digital converter (7-12), and that digital signal is inputted into screen control equipment (7-13). This screen control equipment possesses the display screen (7-14). Moreover, the optical coupling machine (7-4) is combined with the control unit (7-2) through the circuit for control-command transmission (7-15).

[0059] By the measurement approach shown in this drawing 7 , the light from the one light source (7-1) is irradiated to two or more inspected objects (7-6, 7-7), and the optical reinforcement which spread each inspected inside of the body is detected using one photodetector (7-11). In order that the detected light may show clearly whether to be the light which spread which inspected object, the control sequence shown in the following drawing 8 is established. 8-1 is a pulse for control emitted from a control unit (7-2) to an optical coupling

machine (7-4). Although exposure spacing of this pulse is made for example, into 100 mses, there is what is limited to this value, of course. [no]
[0060] If an optical coupling machine (7-4) receives this pulse for control, as shown in 8-2 and 8-3, the optical reinforcement irradiated to the inspected object 1 (7-6) and the inspected object 2 (7-7) will change by turns through the optical fiber for an exposure (7-5). 8-4 and 8-5 are the luminous intensities which spread the interior of the inspected object 1 (7-6) detected by the optical waveguide (7-8) represented by the optical fiber for detection, and the inspected object 2 (7-7), and can be detected synchronizing with the time-of-day dependency of the optical reinforcement respectively shown in 8-2 and 8-3. Such optical reinforcement is changed into an electric signal with a photodetector (7-11) through an optical coupling machine (7-9). The changed result becomes possible within a control unit to discriminate from 8-1 for every light reinforcement which penetrated each inspected object (7-6, 7-6) from the control unit (7-2) synchronizing with the pulse for control (8-1) emitted to an optical coupling machine (7-4).
[0061] In the above, drawing 9 explains how to realize the play equipment reflecting the brain activity depending on organization propagation light reinforcement in the living body, to the object displayed on screen control equipment (7-14 in 6-13 or drawing 7 R> 7 in drawing 6) using the measurement approach shown in drawing 6 or drawing 7 .
[0062] The waging-war mold tug of war as which the inspected object 1 (9-1) and the inspected object 2 (9-2) are displayed is shown in drawing 9 . The blood volume change accompanying the brain activity of each inspected object (the inspected object 1 and inspected object 2) is calculated by the calculation approach shown in the formula 1. For example, when it is blood volume change (B1) of the inspected object 1 (9-1) and blood volume change (B-2) of the inspected object 2 (9-2), the difference of each blood volume change is given by (B1-B-2). 9-3 in drawing 9 is an indicator which displays this difference, and shows the case where it is B1-B-2=2, all over this drawing.
[0063] There is nothing what is limited to this domain, of course all over this drawing although the domain of B1-B-2 shows from -5 to +5. Cerebral active masses differ for every inspected object and every measurement part (every location which prepared the optical fiber for an exposure, and the optical fiber for detection). Consequently, the play equipment reflecting the brain activity depending on organization propagation light reinforcement in the living body is realizable to the object displayed on screen control equipment (7-14 in 6-13 or drawing 7 in drawing 6).
[0064] Drawing 10 is the modification of the measurement approach shown in drawing 4 and drawing 6 . 10-1 is the light source represented by semiconductor laser, light emitting diode, and the lamp. This luminescence reinforcement was controlled by the control unit (10-2), and 10-1 and 10-2 are combined electrically. The end which is represented by semiconductor laser, a light emitting diode, and the lamp and which will be accepted the light source (10-1) is connected to the optical waveguide (10-3) represented by the optical fiber. The tip of two or more optical fibers touches respectively on every 2 skin of the inspected object 1 (10-4) and the inspected object 2 (10-5).
[0065] In the location several centimeters away from the tip of the optical waveguide for an exposure (10-3) represented by each optical fiber, the optical waveguide (10-6) represented by the optical fiber for detection is arranged. For example, although it is desirable to make it about 3 centimeters if the candidate for measurement is concentration change (blood volume change) of the metabolite in the living body accompanying the activity of a Homo sapiens cerebral function, there is nothing what is limited to this value, of course.
[0066] The end is already connected to the photodetector (10-7) which is the optical waveguide represented by the optical fiber for this detection and which is represented by an avalanche photo-diode and the photomultiplier tube. The luminous intensity which spread in the living body is changed into electric signal strength by this photodetector (10-7). And it is inputted into the control unit (10-2) combined electrically. This signal strength inputted into the control device is inputted into an analog-to-digital converter (10-8), and that digital signal is inputted into screen control equipment (10-9). This screen control equipment possesses the display screen (10-10).
[0067] Next, one example of the contents displayed on the display screen (10-10) of drawing 10

is described. The optical fiber used in the example of drawing 10 is arranged on a temporal lobe on either side (movement Nokami). If the digiti manus on either side is made to exercise as mentioned above for example, it will become possible to activate the motor area on either side independently. Then, it becomes possible to reflect the volition of an inspected object by activating the motor area on either side to the object displayed on the screen. Since two or more test subjects are made applicable to measurement, it enables inspected objects to compete. Drawing 11 explains the example which can realize this competition play equipment.
[0068] 11-1 is the display screen and is expressing river going down which used the canoe in this display screen. 11-2 is Kawagishi and a canoe 1 (11-3) and a canoe 2 (11-4) navigate the inside of the river surrounded by Kawagishi. This canoe navigates from the upstream (11-5) to a lower stream of a river (11-6) according to the rate of flow for every point beforehand memorized on the computer. 11-7 is an obstruction, and when a canoe (11-3 and 11-4) contacts this obstruction, a canoe stops navigating (the rate of flow to the direction of a lower stream of a river in this point becomes zero).
[0069] The obstruction shown in 11-7 assumes a rock, driftwood, etc. which exist in a river, and there is what is limited to the configuration of the obstruction displayed into drawing 11 . [no] The canoe 1 (11-8) and canoe 2 (11-9) of a broken-line configuration which were shown in drawing 5 are the location of the canoe in the inside of the river which changed to time series, and they are advancing the inside of a river, without contacting an obstruction (11-7). Thus, what is necessary is just to activate independently the finger motor area which exists in a temporal lobe on either side by making a finger on either side exercise, in order to progress the inside of a river. Consequently, the object displayed on the screen (in the case of drawing 11 , the play equipment reflecting the brain activity depending on organization propagation light reinforcement in the living body is realizable to a canoe (11-3 and 11-4).)
[0070] since the somatometry method using light can use the detector made from a semi-conductor which may be represented by semiconductor laser and light emitting diode and is represented by the light source made from a semi-conductor, and the photodiode, it becomes possible to miniaturize equipment. The example which realizes the play equipment reflecting the brain activity depending on organization propagation light reinforcement in the living body is shown in drawing 12 to this miniaturized metering device and the object displayed on the screen.

[0071] 12-1 is an information terminal that whose the display screen 12-2 is provided it is the description among drawing 12 . The control unit (12-3) that whose the light source and a detector are provided it is the description is connected to the lower part of this information terminal. Drawing 13 explains the example of the internal structure of this control unit. The optical fiber for an exposure (12-4) and the optical fiber for detection (12-5) are connected to the end of a control device. The tip of these optical fibers touches lightly on the skin of an inspected object (12-6). On the display screen, the object (12-7) reflecting a brain activity is displayed. Although the balloon from which height changes according to the amount of the blood volume change accompanying a brain activity is displayed in this example, of course, there is nothing what is limited to this balloon. The example explained using drawing 3 can be used for the method of presentation of this object. Of course, there is nothing what is limited to this method of presentation.
[0072] Next, the internal structure of the control unit shown in 12-3 in drawing 12 is explained using drawing 13 . 13-1 is a power cable and this is offered from the information terminal (12-1) shown in drawing 12 . This power cable is used for the control of a detector (13-3) and an analog-to-digital converter (13-6) represented by semiconductor laser, the light source (13-2) represented by the light emitting diode, an avalanche photodiode, and the photo-multiplier. Moreover, the light source and a detector are connected to the optical waveguide (13-5) represented by the optical fiber through an optical connector (13-4). The detector (13-3) represented by the avalanche photodiode and the photo-multiplier changes into an electric signal the body tissue transmitted light reinforcement which spread the optical waveguide (13-5) represented by the optical fiber, and digitizes it in an analog / digital transducer (13-6). And it transmits to an information terminal (12-1) using the cable for signal transmissions (13-7).

[0073] Optical measurement of the metabolite concentration reflecting a mental condition in the living body or its concentration change was carried out, and the measurement result was made to reflect in the example described above to the positional information of the object by which a screen display was carried out. The reflection approach as shown below besides such a reflection approach can be considered. Drawing 14 is the example of the approach of displaying change (an increment or reduction) of the blood volume accompanying a brain activity by changing the size of the object on a screen.
[0074] In drawing 14 , 14-2 is the size of the object in the blood volume used as criteria. A pair is carried out, and 14-1 and 14-3 show the size of the object at the time of decreasing, when blood volume increases to this blood volume which serves as these criteria respectively. The size of an object will become large if the blood volume within a brain can be increased by praying in the head "Become large" as concrete contents to the object (for example, the body is sufficient and the belly of a frog is sufficient) displayed on the screen. On the other hand, when the measurement location has shifted, it is also possible that blood volume decreases. In that case, the size of an object becomes small.
[0075] Drawing 15 is the example of the approach of displaying change (an increment or reduction) of the blood volume accompanying a brain activity by changing the color (a shade and class) of the object on a screen. 14-2 is the color (for example, red) of the object in the blood volume used as criteria. A pair is carried out, and 15-1 and 15-3 show the color of the object at the time of decreasing, when blood volume increases to this blood volume which serves as these criteria respectively. When the red of the color of criteria changes to crimson with the increment in blood volume, 15-2 shows the case where it changes to pink, with reduction in blood volume 15-1.
[0076] In addition, from the red of criteria, when blood volume increases, for example, changing to blue, and making it change to yellow, when it decreases etc. is considered. If the blood volume within a brain can be increased by praying in the head, "Become blue!" as concrete contents to the object (the red of a signal is displayed) displayed on the screen, the thing that the color of an object becomes blue can be considered. On the other hand, when blood volume decreases, it is possible that the color of an object changes to another color (for example, yellow).
[0077] Next, the example (limiter) of the play equipment which is hard to carry out by impressing fatigue to an inspected object is shown. 16-1 in drawing 16 shows this example as a flow chart. The algorithm based on this flow chart is saved at the storage which exists in the computer shown in 1-8. Below, the outline of the flow chart shown in 16-1 is explained.
[0078] First, a game is started (16-2). And first, convention time amount is set up (16-3), and it saves at storage. This convention time amount is set up with 30 etc. minutes etc. Since a player will generally be devoted if this performs a game, he tends to forget to pass at the time. Consequently, it is for playing a long duration game and sensing unexpected fatigue. This convention measurement time amount can be set as arbitration according to the class of contents of a game, or the individual corporal description.
[0079] Next, a sample task is carried out (16-4). This presents "please move a hand" or "please remember that it was pleasant until now", and a message to an inspected object, passes in the living body using the optical exposure machine and photodetector which have been arranged on an inspected object, and detects change of the reinforcement of the transmitted light. Change of the detection light reinforcement to a resting period is set to x here, and this is also saved in storage (16-5). The threshold parameter k about change of transmitted light reinforcement is further set to this storage. It is possible to also set this threshold as arbitration according to the class of contents of a game or the individual corporal description.
[0080] And the game of Maine is performed. First, the accumulation measurement time amount after a game is started is found. If this accumulation measurement time amount is in convention measurement time amount (criteria exposure period), measurement will be continued, and measurement (game) will be interrupted if it is no (16-6). Next, the check of the change of transmitted light reinforcement is carried out (16-7), and it judges whether it is larger than the threshold (xxk) which the reinforcement set up, or small (16-8). When smaller than the threshold which change of transmitted light reinforcement set up, it continues a game (16-9). On the other

hand, a game is interrupted when larger than a threshold (16–10). And the interrupted purport is shown to an inspected object (16–11), and the light source is turned off (16–12).
[0081] Next, how to carry out the check of the change of transmitted light reinforcement is explained using the following drawing 17 . First, as shown in 17–1 in drawing 17 (a), according to spacing of a certain time of day, the trigger for inspecting detection light reinforcement (transmitted light reinforcement) is emitted. Even if the recurrence interval of this trigger is spacing of not only regular intervals [like] but arbitration shown in drawing, it is satisfactory in any way. And corresponding to this trigger, the body tissue transmitted light reinforcement (detection light reinforcement) inputted into the computer is checked.
[0082] 17–2 in drawing 17 (b) shows one example of the check approach. 17–3 shows the time dependency of body tissue transmitted light reinforcement. Moreover, 17–4 shows in piles the timing by which the trigger shown in 17–1 was emitted on 17–2. Furthermore, 17–5 shows a certain predetermined threshold reinforcement. This threshold reinforcement is set as any value for every inspected object and every play equipment. In the case of 17–2, in the period 17–6, transmitted light reinforcement is less than threshold reinforcement.
[0083] Next, how to show the purport that measurement (game) was interrupted, to an inspected object is explained using drawing 18 . 18–1 in drawing is a computer, and this computer possesses the screen for a display (18–2), and the loudspeaker for voice presentation (18–3), in order to realize the play equipment reflecting the brain activity depending on organization propagation light reinforcement in the living body. As shown in drawing 1616 , in order to show the purport that measurement (game) was interrupted, to an inspected object, the message "game termination" is displayed in the first place on the screen for a display (18–2).
[0084] In other words, showing on a screen the message of the purport which ends a game, and the display of a screen are changed with during the usual game operation period. A message flows in the purport which ends measurement, for example, "game termination", from the loudspeaker for voice presentation (18–3) by the same approach as this. Although the sound effect etc. is flowing in the usual game in order to raise the presence of a game from this loudspeaker, during a game operation period usual in audio presentation, it is the description in passing this message to make it change.
[0085]
[Effect of the Invention] It is the description for the play equipment offered by this invention to carry out optical measurement of the metabolite concentration reflecting a mental condition in the living body or its concentration change, to pass through the measurement result to the object by which a screen display was carried out, and to be reflected as stated above. Consequently, it becomes possible to control the object on a screen, without using the input device represented by a mouse, a joy stick, the handle, etc. Consequently, when it can become new play equipment, it becomes possible further to enjoy play equipment, without using a hand and a guide peg.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention] This invention relates to play equipment and relates to the play equipment using the living body light mensuration which measures change of the optical reinforcement which penetrated in the living body reflecting the metabolite concentration in the living body which reflects a mental condition and a brain activity especially, or its concentration change.

[Translation done.]

PRIOR ART

[Description of the Prior Art] A computer, a game, an environment control unit, the living body input unit using the Mitsuo object mensuration which controls judgment equipment, the alarm of a vehicle, a medical-application diagnosis and an alarm, the lie detector, declaration-of-intention equipment, a data transmission unit, etc. whenever [study], and biological control equipment are proposed in JP,9-149894,A by measuring the localized cerebral function and inputting into an external device. Hereafter, this is explained using drawing 19 .

[0003] In order to irradiate light to an inspected object, the light source (19-1) represented by semiconductor laser, a light emitting diode, and the lamp and the optical waveguide (19-2) (the above is named generically and it considers as an optical exposure machine) represented by the optical fiber for an exposure are used. Although it is optimal that the permeability of a body tissue uses light with a high wavelength of about 800 nanometers as for the wavelength of the light used for measurement, it is not limited to this wavelength range.

[0004] The both ends of optical waveguide touch, respectively on the skin of the light source (19-1) and an inspected object (19-3). The light irradiated to the living body is strongly scattered about by the body tissue. However, a part of the scattered light passes the cerebral cortex which the higher brain function represented by movement, feeling, and language concentrates, and it reaches again to the scalp which separated about 30 millimeters (in the case of an adult) from the optical exposure location.

[0005] A photodetector is arranged in order to detect the luminous intensity which spread in the living body in this location. This photodetector consists of the photodiodes and the photoelectric elements (19-5) represented by the photomultiplier tube which contacted that end to the optical waveguide (19-4) represented by the optical fiber. It is changed into an electric signal from an optical signal using this photodetector. And this electric signal is processed using a computer (19-6).

[0006] Here, it is assumed that it made the brain work by moving the bodies (a hand, guide pegs, these fingers, etc.), considering an object, or praying. If a brain works, in order to supply oxygen and a glucose to a cerebral activity part, the blood volume in the cerebral cortex changes by increasing or decreasing secondarily. If near-infrared light (wavelength of about 800 nanometers) is used for measurement, in order that the hemoglobin in blood (an oxyhemoglobin, reduced hemoglobin) may absorb this light used for measurement, the quantity of light which reached to the optical fiber for detection will decrease, if the amount of hemoglobin increases with a brain activity. For this reason, change of the detected luminous intensity reflects a cerebral activity. This luminous-intensity change is measured and the input unit which measures thinking of the Homo sapiens reflecting a mental condition or a brain activity, and controls a computer by controlling a computer using this measurement result is realized.

EFFECT OF THE INVENTION

[Effect of the Invention] It is the description for the play equipment offered by this invention to carry out optical measurement of the metabolite concentration reflecting a mental condition in the living body or its concentration change, to pass through the measurement result to the object by which a screen display was carried out, and to be reflected as stated above. Consequently, it becomes possible to control the object on a screen, without using the input device represented by a mouse, a joy stick, the handle, etc. Consequently, when it can become new play equipment, it becomes possible further to enjoy play equipment, without using a hand and a guide peg.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] Two technical problems shown below are solved in this invention.
[0008] The play equipment which used the above-mentioned living body light metering device for the 1st is realized. Generally, play equipment possesses the input device represented by a mouse, a joy stick, a handle, the touch panel, etc., and the Braun-tube display, the liquid crystal display and the presentation equipment represented by the light emitting diode array that whose the input result is shown to a player it is the description. These existing input units move a hand and a guide peg based on the command from a brain, and inputting the command from a brain into a computer using these hands or a guide peg is mentioned as a common feature. Various play equipments are already realized because the location of the object displayed on presentation equipment, a gestalt, and the "condition" of being represented by size change according to this input.
[0009] On the other hand, although it is possible to input into a computer as it is that Homo sapiens considers the living body input unit indicated in JP,9-149894,A not using a hand or a guide peg, the operation means of the concrete play equipment using this living body input unit is not indicated at all. If play equipment is realized concretely, it will enable various persons for it to be able to become play equipment new also for a difficult person to move not only a healthy person but a hand and a guide peg, consequently to enjoy itself using the same play equipment.
[0010] So, in this invention, the command from a brain and a cerebral activity are inputted into a direct computer using optical cerebral function mensuration, and it sets it as the 1st purpose to realize the play equipment based on the input result.
[0011] The Homo sapiens cerebral function activated when Homo sapiens is going to consider an object, pray an object or specifically move a hand and a guide peg in the first place is measured using light. The play equipment which makes it possible to reflect the measurement result of an activity of this Homo sapiens cerebral function in the second to the object displayed on the screen of a computer is realized.
[0012] It sets it as the 2nd purpose to offer the contents of the game in which fatigue is not impressed because a player focuses [2nd] on a game too much in the above-mentioned play equipment by this invention.
[0013] Above play equipment controls a computer using the human brain activity. Since in other words the human brain activity is controlled using the head, it may get fatigued in order to use the head. Moreover, when the contents of the created game are interesting for a player, he forgets for time amount to pass, it is absorbed in a game, and, as a result, fatigue may be sensed. Then, the example of the game in which fatigue is not impressed such is offered.

[Translation done.]

MEANS

[Means for Solving the Problem] Measurement field division of the human brain is carried out like by different cytoarchitecture expressed by Broadmann's atlas of brain. Furthermore, each of these fields share a different function. For example, if a brain is seen from width, the field where the field which participates in spontaneous movements (a hand, a guide peg, finger, etc.) participates in the summit section, feeling, and vision will share the field about the regio occipitalis capitis and language with the predetermined section of a left half.
[0015] In this invention, in order to extract the information from the location pinpointed in this way with high degree of accuracy, living body light mensuration with high spatial resolving power is used (in measurement of an electroencephalogram, since the dielectric constant in a living body is uneven, the source location of a signal becomes indefinite, and spatial resolving power is low.). Moreover, since myoelectric potential is greatly reflected in a signal to a motion of a test subject's body, there is also a difficulty of restraining a test subject.
[0016] This living body light mensuration by irradiating the inspected body skin skin on the skin of an unit or two or more inspected objects from at least one optical exposure machine and this optical exposure machine At least one photodetector arranged on the inspected body skin skin for condensing the passage light inside this inspected body skin skin, and measuring this condensed inspected object passage light reinforcement, It consists of operation part which calculates concentration change of the metabolite in the living body measured using these light exposure machine and the photodetector.
[0017] And with the play equipment based on this invention, it is the description that the operation part of this living body light mensuration has connected with the display possessing the display screen. And at least one existing object is displayed on the display screen in this display. It is the description that the location of this object, a gestalt, and the "condition" of being represented by size change according to signal luminous-intensity change which penetrated in the living body. It becomes possible to visualize concentration change of the metabolite in the living body accompanying a brain activity by this. Consequently, an inspected object is making one's brain work, it becomes possible to change the location of the object displayed on the screen, a gestalt, and the "condition" of being represented by size, and the play equipment which this invention makes the purpose can be realized. In addition, even if operation part and the display screen are one, they may be the configuration of having become independent.
[0018] Thus, at least one optical exposure machine for this invention to irradiate light at a living body, At least one photodetector for condensing the passage light which it irradiated from said optical exposure machine, and spread in the living body [said], The display equipped with the display screen which displays at least one object, It has the operation part which controls said display based on the measurement signal about said passage luminous intensity measured with said photodetector. And the play equipment using the living body light mensuration characterized by constituting so that the condition that said at least one object displayed on said display screen is included according to a change of the measurement signal measured by said at least one photodetector on the strength may change is offered.
[0019] Moreover, at least one optical exposure machine for this invention to irradiate light at two

or more living bodies, At least one photodetector for condensing the passage light which it irradiated from said optical exposure machine, and spread in the living body [said], The operation part equipped with the display screen which displays at least one object, It has the operation part which controls said display based on the measurement signal about said passage luminous intensity measured with said photodetector. And the play equipment using the living body light mensuration characterized by constituting so that the condition that one or more objects displayed on said display screen are included according to a change of the measurement signal measured by said at least one photodetector on the strength may change is offered.
[0020] Moreover, at least one optical exposure machine for this invention to irradiate light through waveguide at two or more living bodies' each, At least one photodetector for condensing the passage light which it irradiated from this optical exposure machine, and spread in the living body [said], The display equipped with the display screen which displays at least one object, It has the operation part which controls said display based on the measurement signal about said passage luminous intensity measured with said photodetector. And the play equipment using the living body light mensuration characterized by constituting so that the condition that one or more objects displayed on said display screen are included according to a change of the measurement signal measured by said at least one photodetector on the strength may change is offered.
[0021] Moreover, the play equipment using the living body light mensuration characterized by constituting so that this invention may make an optical exposure machine, a photodetector, a display, and operation part build in the same information terminal in said configuration and some of optical exposure machines and photodetectors may be combined with the terminal of said information terminal is offered.
[0022] This invention is set in said configuration. Furthermore, operation part It comes to contain the function to memorize the accumulation time amount and the criteria exposure period which irradiated light from the optical exposure machine, and the loudspeaker which utters voice. and the command into which the configuration on the display screen is made to change when the accumulation time amount which irradiated light from the optical exposure machine exceeds a criteria exposure period — or the play equipment using the living body light mensuration characterized by constituting so that the command which makes the voice uttered from a loudspeaker change may be issued is offered.
[0023] The play equipment using the living body light mensuration characterized by to constitute this invention further again so that the command which makes the voice which is made to change the configuration on the display screen , or is uttered from a loudspeaker change may issue , when the reinforcement of the transmitted light exceeds a predetermined threshold , even if the accumulation time amount to which operation part irradiated light from the optical exposure machine in said configuration is within said criteria exposure period offers .
[0024]
[Embodiment of the Invention] In this invention, the activity situation of the cerebral function localized using light is measured, and the measured signal is used as an input signal of operation part, such as a computer. One or more optical exposure machines and one or more photodetectors are contacted on the skin of one or more persons' inspected object, and, specifically, luminous-intensity change which penetrated in the living body is measured. This measurement result reflects concentration change of the metabolites (an oxyhemoglobin, reduced hemoglobin, etc.) in the living body accompanying a brain activity. This measurement result is used as an input signal to operation part. The display (presentation) screen to an inspected object exists in the display connected to operation part, and one or more objects exist on the screen. According to change (or luminous-intensity change which penetrated in the living body) of the input signal reinforcement to the operation part reflecting the concentration of a metabolite in the living body, concentration change, i.e., this concentration, or concentration change, the gestalten (a location, color, size, etc.) of one or more objects change.
[0025] That is, a cerebral function is measured using light and the play equipment from which the condition of the object on the display screen connected to operation part, such as a computer, according to the active state of a cerebral function changes can be realized.

[0026] Hereafter, the example about this invention is concretely explained using drawing.
[0027] One Mitsuteru gunner stage and one photodetection means are used for drawing 1 on one player , it measures the concentration of metabolites (for example , the oxyhemoglobin in blood , the reduced hemoglobin , a cytochrome , etc.) in the living body , or its concentration change , and shows one example which realizes the play equipment reflecting the brain activity depending on organization propagation light reinforcement in the living body to the object displayed on the screen . 1-1 is the light source represented by semiconductor laser, light emitting diode, and the lamp, and the tip is connected with optical waveguide (for example, optical fiber) 1-2.
[0028] that of an optical fiber is also obtained and the end touches on the skin of an inspected object (1-3) (for example, scalp on). the scalp — the case where it contacts upwards — the scalp — the hair of the hair which exists upwards — pushing aside — the scalp — it is desirable for the tip of direct optical waveguide to touch upwards. Because, when the light used for measurement is absorbed by the hair of hair, it is for optical exposure effectiveness to fall.
[0029] 1-4 — optical waveguide (1-2) — it is the optical fiber for detection used in order to detect the light which it therefore irradiated and spread the interior of an inspection object (103). The end of this optical fiber (1-4) touches on the skin of an inspected object (1-3) (for example, scalp on). a reason with the same said of the end of this optical fiber — the scalp — the hair of the hair which exists upwards — pushing aside — the scalp — it is desirable for the tip of direct optical waveguide to touch upwards. Moreover, the end is already connected to the photodetector (1-5) represented by an avalanche photo-diode and the photomultiplier tube. These light sources (1-1) and a photodetector (1-5) are electrically connected with the control unit (1-6). This control device (1-6) is connected with the operation part (1-8) represented by the computer etc. through an analog-to-digital converter (1-7).
[0030] Transmission of bidirectional information is possible for this control unit (1-6) and operation part (1-8) to mutual. A control unit (1-6) can adjust the quantity of light to the light source (for example, the luminescence reinforcement of the light source which generates the light source of the shape of ON of the light source or OFF, and a pulse is modulated with a certain angular frequency).
[0031] Moreover, operation part (1-8) possesses the store (for example, a hard disk, memory), in order to store temporarily or eternally the information on detected luminous-intensity change (time-of-day dependency). The optical analog reinforcement which reached the photodetector (1-5) is changed into digital optical reinforcement through an analog-to-digital converter (1-7), and the result is transmitted to operation part (1-8).
[0032] Moreover, the signal which directs quantity of light adjustment of the light source is transmitted to a control unit (1-6) from operation part (1-8). In this example, although a control device (1-6), analog-to-digital-conversion equipment (1-7), and operation part (1-8) have separate isolated-system composition, even if they are the unified equipment configuration, they are satisfactory in any way.
[0033] Moreover, in order to realize the play equipment which reflects the brain activity depending on organization propagation light reinforcement in the living body on a computer (1-8) to the object displayed on the screen, it has the display equipped with the display screen (1-9). The configuration of this display screen (1-9) is explained using another example. In addition, operation part may really be a configuration or this display may be a separate isolated-system configuration.
[0034] Next, how to measure change of metabolite concentration in the living body is explained using the measurement approach shown in drawing 2 .
[0035] first, the measurement approach shown in drawing 2 — using — the optical waveguide for an optical exposure (2-1), and the optical waveguide for detection — (2-2) — the scalp of an inspected object (2-3) — it is made to contact upwards As for a human brain, a skull (2-4), a cerebrospinal fluid layer (2-5), the cerebral cortex (2-6), etc. exist in the shape of a layer inside the scalp. here, as for the optical waveguide for an optical exposure (2-1), and the optical waveguide for detection (2-2), an inspected object (2-3) does not sense a pain — like — the scalp — it is made to contact lightly upwards
[0036] Here, body tissues are strongly scattered about in light. For this reason, a part of

scattered light reaches via the cerebral cortex (2–6) which exists inside a skull (2–4) and the higher brain function of a Homo sapiens proper is concentrating to the contact location of the scalp of the optical waveguide for detection (2–2), and an inspected object (2–3), as shown in drawing 2 (a). In the adult, generally, this attainment location is separated from the optical exposure location (scalp of the optical waveguide for an optical exposure (2–1) upper contact location) about 30mm.

[0037] Here, in order to supply oxygen and a glucose to the activity part of a cranial nerve cell as shown in drawing 2 (b) if a brain works, the blood volume in the cerebral cortex (oxyhemoglobin concentration, reduction hemoglobin concentration) changes (2–7). It is most desirable for body tissue permeability to use for measurement the near–infrared light (wavelength: before or after 800 nanometers) absorbed highly (water and protein in a living body being hard to be measured) by the hemoglobin in blood (an oxyhemoglobin, reduced hemoglobin). Of course, there is nothing what is limited to the light of this wavelength object. Here, if the blood volume of the cerebral cortex increases because a brain works (reduction), the luminous intensity detected will decrease (increment).

[0038] Next, one example of the contents of the play equipment reflecting the brain activity (nerve activity) depending on organization propagation light reinforcement in the living body is shown to the object displayed on the screen using the instrumentation system shown in drawing 1 .

[0039] First, the related example of luminous intensity and measurement time amount which penetrated the body tissue to 3–1 in drawing 3 (a) is shown. In this measurement, the optical fiber for an optical exposure and the optical fiber for photodetection which were shown in drawing 1 have been arranged at intervals of 30mm on 1–centimeter left eyebrow hair top the "frame" of a certain inspected object. During the measurement period in this drawing (50 seconds), in 10 to 30 seconds (for 20 seconds), an inspected object is 1Hz about that right hand, and repeated "it is good" and a "par." On the other hand, in such time amount, the inspected object took the rest condition. After detection light reinforcement decreases after [of an after / task initiation] several seconds and a task is completed from this measurement result, it turns out that detection light reinforcement is increasing. This corresponds with metabolite concentration (hemoglobin concentration) in the living body increasing by cerebral activity.

[0040] Then, one example of contents as shown in 3–2 in drawing 3 (b) is offered. From these contents, a balloon (3–3) exists on a screen. This balloon exists in the location of height x to the ground (3–4).

[0041] The decision approach of this height x will be determined as follows, if the related example (3–1) of luminous intensity and measurement time amount which penetrated the body tissue is imitated. Whether it is the average in this period even if it is a certain criteria reinforcement and is the reinforcement in the arbitration time of day in a measurement period (during a play equipment operation period), or the detection light reinforcement of t= 0 in a formula (1) is the criteria reinforcement determined as arbitration in addition to this, it is not cared about. Of course, there is nothing what is limited to the decision approach using this formula (1).

[0042]

x=ln {(detection light reinforcement of t= 0) /(detection light reinforcement in time of day t)} ..... Formula (1)

According to this formula (1), if transmitted light reinforcement decreases, x will increase, and on the other hand, if transmitted light reinforcement increases, x will decrease. For this reason, when a brain works, it turns out that the height of a balloon becomes high. It was activated, when Homo sapiens was going to consider an object in the first place by using the above approach, an object tended to be prayed or it was going to move a hand and a guide peg, and the Homo sapiens cerebral function which is invisible was able to be measured, that result was able to be inputted into the direct computer the second, and the play equipment from which the object displayed on the third on the screen according to the brain activity when visualizing and putting in another way this Homo sapiens cerebral function changes was able to be realized.

[0043] The modification of the example described above is described below.

[0044] Drawing 4 sets up two or more measure points on the skin of an inspected object, and measures concentration change of the matter concentration in a metabolic turnover in these two or more measure points. And based on the measurement result of these concentration change, the example which realizes the play equipment reflecting the brain activity depending on organization propagation light reinforcement in the living body is described to the object displayed on the screen. 4-1 is the light source represented by semiconductor laser, light emitting diode, and the lamp. This luminescence reinforcement was controlled by the control unit (4-2), and 4-1 and 4-2 are combined electrically.
[0045] The end which is represented by semiconductor laser, a light emitting diode, and the lamp and which will be accepted the light source (4-1) was connected to the optical waveguide (4-3) represented by the optical fiber, and this optical fiber is further connected to the optical waveguide for an exposure (4-5) represented by two or more optical fibers with an optical coupling vessel (4-4). The tip of the optical fiber of these plurality touches on two or more [on the skin of an inspected object (4-6)]. For example, it is possible to arrange to a temporal lobe on either side, respectively. Of course, you may arrange at the point of the arbitration on not the thing limited to this configuration method but the skin of an inspected object. In the location several centimeters away from the tip of the optical waveguide for an exposure (4-5) represented by each optical fiber, the optical waveguide (4-7) represented by the optical fiber for detection is arranged. For example, although it is desirable to make it about 3 centimeters if the candidate for measurement is concentration change (blood volume change) of the metabolite in the living body accompanying the activity of a Homo sapiens cerebral function, of course, there is nothing what is limited to this value.
[0046] The end which is represented by the optical fiber for this detection and which will be accepted optical waveguide (4-7) is connected to the photodetector (4-8) represented by an avalanche photo-diode and the photomultiplier tube. The luminous intensity which spread in the living body is changed into electric signal strength by this photodetector (4-8). And it is inputted into the control unit (4-2) combined electrically. This signal strength inputted into the control device (4-2) is inputted into an analog-to-digital converter (4-9), and that digital signal is inputted into operation part (screen control equipment) (4-10). In this example, this screen control equipment (4-10) possesses the display screen (4-11). The contents displayed on the display screen mention later. If the measurement approach described above is used, the play equipment reflecting the brain activity depending on organization propagation light reinforcement in the living body is realizable to the object displayed on the screen described below.
[0047] the optical waveguide for an exposure (4-5) represented by the optical fiber shown in drawing 4 — the scalp — it is arranged at two or more upper points. The Homo sapiens cerebral function is localized on the cerebral cortex for every function. For example, if one of this optical waveguide is installed on a left temporal lobe and one more is installed on a right temporal lobe, it will become possible to measure the brain activity of the right finger motor area and the **** motor area, respectively. moving a right finger, if it has another way of speaking — a left temporal lobe — being activable — consequently, the scalp of an inspected object (4-6) — it becomes possible to measure activation of the brain in a left temporal lobe using the optical waveguide for an exposure (4-5) installed upwards, and the optical waveguide (4-7) represented by the optical fiber for detection. similarly moving a left finger — a right temporal lobe — being activable — consequently, the scalp of an inspected object (4-6) — it becomes possible to measure activation of the brain in a right temporal lobe using the optical waveguide for an exposure (4-5) installed upwards, and the optical waveguide (4-7) represented by the optical fiber for detection. Thus, it becomes possible by installing two or more measure points to measure two or more kinds of brain activities.
[0048] Then, drawing 5 explains how to realize the play equipment reflecting the brain activity depending on organization propagation light reinforcement in the living body, to the object displayed on a display screen (4-11). 5-1 is the display screen and is expressing river going down which used the canoe in this display screen. 5-2 is Kawagishi and a canoe (5-3) navigates the inside of the river surrounded by Kawagishi. This canoe navigates from the upstream (5-4) to a lower stream of a river (5-5) according to the rate of flow for every point beforehand memorized

on the computer.
[0049] 5-6 in drawing 5 is an obstruction, and when a canoe (5-4) contacts this obstruction, a canoe stops navigating. The obstruction stated to 5-6 assumes a rock, driftwood, etc. which exist in a river, and there is what is limited to the configuration of the obstruction displayed into drawing 5 . [no] The canoe (5-7) of the broken-line configuration shown in drawing 5 is the location of the canoe in the inside of the river which changed to time series, and it is advancing the inside of a river, without contacting an obstruction (5-6). Thus, what is necessary is just to activate independently the finger motor area which exists in a temporal lobe on either side by making a finger on either side exercise, in order to progress the inside of a river.
[0050] Consequently, the play equipment reflecting the brain activity depending on organization propagation light reinforcement in the living body is realizable to the object (in the case of drawing 5 canoe (5-3)) displayed on the screen.
[0051] There is the outstanding description which is not in the cerebral function mensuration (for example, functional MAG drawing equipment) which used the MAG, the cerebral function mensuration (for example, electroencephalograph) using the electrical and electric equipment, and the cerebral function mensuration (for example, positive electron exposure tomogram drawing equipment) using a radiation in the cerebral function mensuration using the light described above. It is that it is possible to measure the localized Homo sapiens cerebral function safely, even if equipment is small. For this reason, it is also possible to measure two or more Homo sapiens cerebral function to coincidence. Then, it explains using the example which realizes the play equipment reflecting the brain activity depending on organization propagation light reinforcement in the living body to the object which measured two or more Homo sapiens cerebral function to coincidence, consequently was displayed on the screen.
[0052] Drawing 6 is one gestalt of the example in the case of carrying out coincidence measurement of two or more inspected objects. 6-1 is the light source represented by semiconductor laser, light emitting diode, and the lamp. This luminescence reinforcement was controlled by the control unit (6-2), and 6-1 and 6-2 are combined electrically. The end which is represented by semiconductor laser, a light emitting diode, and the lamp and which will be accepted the light source (6-1) was connected to the optical waveguide (6-3) represented by the optical fiber, and this optical fiber is further connected to the optical waveguide (6-5) represented by two or more optical fibers with an optical coupling vessel (6-4). The tip of the optical fiber of these plurality touches respectively on the skin of the inspected object 1 (6-6) and the inspected object 2 (6-7).
[0053] In the location several centimeters away from the tip of the optical waveguide for an exposure (6-5) represented by each optical fiber, the optical waveguide (6-8) represented by the optical fiber for detection is arranged. For example, although it is desirable to make it about 3 centimeters if the candidate for measurement is concentration change (blood volume change) of the metabolite in the living body accompanying the activity of a Homo sapiens cerebral function, there is nothing what is limited to this value, of course.
[0054] The end which is represented by the optical fiber for this detection and which will be accepted optical waveguide (6-8) is connected to the photodetector (6-9 and 6-10) represented by an avalanche photo-diode and the photomultiplier tube. The luminous intensity which spread in the living body is changed into electric signal strength by this photodetector. And it is inputted into the control unit (6-2) combined electrically. This signal strength inputted into the control device is inputted into an analog-to-digital converter (6-11), and that digital signal is inputted into screen control equipment (6-12). This screen control equipment possesses the display screen (6-13). The contents displayed on the display screen mention later.
[0055] By the measurement approach described above, the photodetector (6-9 and 6-10) represented by an avalanche photo-diode and the photomultiplier tube became two or more place important point. Then, in the following examples, drawing 7 explains the mensuration which can measure two or more inspected objects to coincidence with the number of fewer detectors. 7-1 is the light source represented by semiconductor laser, light emitting diode, and the lamp. This luminescence reinforcement was controlled by the control unit (7-2), and 7-1 and 7-2 are combined electrically.

[0056] The end which is represented by semiconductor laser, a light emitting diode, and the lamp and which will be accepted the light source (7-1) was connected to the optical waveguide (7-3) represented by the optical fiber, and this optical fiber is further connected to the optical waveguide (7-5) represented by two or more optical fibers with an optical coupling vessel (7-4). The tip of the optical fiber of these plurality touches respectively on the skin of the inspected object 1 (7-6) and the inspected object 2 (7-7).
[0057] In the location several centimeters away from the tip of the optical waveguide for an exposure (7-5) represented by each optical fiber, the optical waveguide (7-8) represented by the optical fiber for detection is arranged. For example, although it is desirable to make it about 3 centimeters if the candidate for measurement is concentration change (blood volume change) of the metabolite in the living body accompanying the activity of a Homo sapiens cerebral function, there is nothing what is limited to this value, of course. The end which is represented by the optical fiber for this detection and which will be accepted optical waveguide (7-8) is combined with the optical coupling machine (7-9).
[0058] The output from this optical coupling machine is connected to the photodetector (7-11) represented by an avalanche photo-diode and the photomultiplier tube through the optical waveguide (7-10) represented by the optical fiber. The luminous intensity which spread in the living body is changed into electric signal strength by this photodetector. And it is inputted into the control unit (7-2) combined electrically. This signal strength inputted into the control device is inputted into an analog-to-digital converter (7-12), and that digital signal is inputted into screen control equipment (7-13). This screen control equipment possesses the display screen (7-14). Moreover, the optical coupling machine (7-4) is combined with the control unit (7-2) through the circuit for control-command transmission (7-15).
[0059] By the measurement approach shown in this drawing 7 , the light from the one light source (7-1) is irradiated to two or more inspected objects (7-6, 7-7), and the optical reinforcement which spread each inspected inside of the body is detected using one photodetector (7-11). In order that the detected light may show clearly whether to be the light which spread which inspected object, the control sequence shown in the following drawing 8 is established. 8-1 is a pulse for control emitted from a control unit (7-2) to an optical coupling machine (7-4). Although exposure spacing of this pulse is made for example, into 100 mses, there is what is limited to this value, of course. [no]
[0060] If an optical coupling machine (7-4) receives this pulse for control, as shown in 8-2 and 8-3, the optical reinforcement irradiated to the inspected object 1 (7-6) and the inspected object 2 (7-7) will change by turns through the optical fiber for an exposure (7-5). 8-4 and 8-5 are the luminous intensities which spread the interior of the inspected object 1 (7-6) detected by the optical waveguide (7-8) represented by the optical fiber for detection, and the inspected object 2 (7-7), and can be detected synchronizing with the time-of-day dependency of the optical reinforcement respectively shown in 8-2 and 8-3. Such optical reinforcement is changed into an electric signal with a photodetector (7-11) through an optical coupling machine (7-9). The changed result becomes possible within a control unit to discriminate from 8-1 for every light reinforcement which penetrated each inspected object (7-6, 7-6) from the control unit (7-2) synchronizing with the pulse for control (8-1) emitted to an optical coupling machine (7-4).
[0061] In the above, drawing 9 explains how to realize the play equipment reflecting the brain activity depending on organization propagation light reinforcement in the living body, to the object displayed on screen control equipment (7-14 in 6-13 or drawing 7 R> 7 in drawing 6) using the measurement approach shown in drawing 6 or drawing 7 .
[0062] The waging-war mold tug of war as which the inspected object 1 (9-1) and the inspected object 2 (9-2) are displayed is shown in drawing 9 . The blood volume change accompanying the brain activity of each inspected object (the inspected object 1 and inspected object 2) is calculated by the calculation approach shown in the formula 1. For example, when it is blood volume change (B1) of the inspected object 1 (9-1) and blood volume change (B-2) of the inspected object 2 (9-2), the difference of each blood volume change is given by (B1-B-2). 9-3 in drawing 9 is an indicator which displays this difference, and shows the case where it is B1-B-2=2, all over this drawing.

[0063] There is nothing what is limited to this domain, of course all over this drawing although the domain of B1-B-2 shows from -5 to +5. Cerebral active masses differ for every inspected object and every measurement part (every location which prepared the optical fiber for an exposure, and the optical fiber for detection). Consequently, the play equipment reflecting the brain activity depending on organization propagation light reinforcement in the living body is realizable to the object displayed on screen control equipment (7-14 in 6-13 or drawing 7 in drawing 6).
[0064] Drawing 10 is the modification of the measurement approach shown in drawing 4 and drawing 6 . 10-1 is the light source represented by semiconductor laser, light emitting diode, and the lamp. This luminescence reinforcement was controlled by the control unit (10-2), and 10-1 and 10-2 are combined electrically. The end which is represented by semiconductor laser, a light emitting diode, and the lamp and which will be accepted the light source (10-1) is connected to the optical waveguide (10-3) represented by the optical fiber. The tip of two or more optical fibers touches respectively on every 2 skin of the inspected object 1 (10-4) and the inspected object 2 (10-5).
[0065] In the location several centimeters away from the tip of the optical waveguide for an exposure (10-3) represented by each optical fiber, the optical waveguide (10-6) represented by the optical fiber for detection is arranged. For example, although it is desirable to make it about 3 centimeters if the candidate for measurement is concentration change (blood volume change) of the metabolite in the living body accompanying the activity of a Homo sapiens cerebral function, there is nothing what is limited to this value, of course.
[0066] The end is already connected to the photodetector (10-7) which is the optical waveguide represented by the optical fiber for this detection and which is represented by an avalanche photo-diode and the photomultiplier tube. The luminous intensity which spread in the living body is changed into electric signal strength by this photodetector (10-7). And it is inputted into the control unit (10-2) combined electrically. This signal strength inputted into the control device is inputted into an analog-to-digital converter (10-8), and that digital signal is inputted into screen control equipment (10-9). This screen control equipment possesses the display screen (10-10).
[0067] Next, one example of the contents displayed on the display screen (10-10) of drawing 10 is described. The optical fiber used in the example of drawing 10 is arranged on a temporal lobe on either side (movement Nokami). If the digiti manus on either side is made to exercise as mentioned above for example, it will become possible to activate the motor area on either side independently. Then, it becomes possible to reflect the volition of an inspected object by activating the motor area on either side to the object displayed on the screen. Since two or more test subjects are made applicable to measurement, it enables inspected objects to compete. Drawing 11 explains the example which can realize this competition play equipment.
[0068] 11-1 is the display screen and is expressing river going down which used the canoe in this display screen. 11-2 is Kawagishi and a canoe 1 (11-3) and a canoe 2 (11-4) navigate the inside of the river surrounded by Kawagishi. This canoe navigates from the upstream (11-5) to a lower stream of a river (11-6) according to the rate of flow for every point beforehand memorized on the computer. 11-7 is an obstruction, and when a canoe (11-3 and 11-4) contacts this obstruction, a canoe stops navigating (the rate of flow to the direction of a lower stream of a river in this point becomes zero).
[0069] The obstruction shown in 11-7 assumes a rock, driftwood, etc. which exist in a river, and there is what is limited to the configuration of the obstruction displayed into drawing 11 . [no] The canoe 1 (11-8) and canoe 2 (11-9) of a broken-line configuration which were shown in drawing 5 are the location of the canoe in the inside of the river which changed to time series, and they are advancing the inside of a river, without contacting an obstruction (11-7). Thus, what is necessary is just to activate independently the finger motor area which exists in a temporal lobe on either side by making a finger on either side exercise, in order to progress the inside of a river. Consequently, the object displayed on the screen (in the case of drawing 11 , the play equipment reflecting the brain activity depending on organization propagation light reinforcement in the living body is realizable to a canoe (11-3 and 11-4).)
[0070] since the somatometry method using light can use the detector made from a semi-

conductor which may be represented by semiconductor laser and light emitting diode and is represented by the light source made from a semi-conductor, and the photodiode, it becomes possible to miniaturize equipment. The example which realizes the play equipment reflecting the brain activity depending on organization propagation light reinforcement in the living body is shown in drawing 12 to this miniaturized metering device and the object displayed on the screen.

[0071] 12-1 is an information terminal that whose the display screen 12-2 is provided it is the description among drawing 12 . The control unit (12-3) that whose the light source and a detector are provided it is the description is connected to the lower part of this information terminal. Drawing 13 explains the example of the internal structure of this control unit. The optical fiber for an exposure (12-4) and the optical fiber for detection (12-5) are connected to the end of a control device. The tip of these optical fibers touches lightly on the skin of an inspected object (12-6). On the display screen, the object (12-7) reflecting a brain activity is displayed. Although the balloon from which height changes according to the amount of the blood volume change accompanying a brain activity is displayed in this example, of course, there is nothing what is limited to this balloon. The example explained using drawing 3 can be used for the method of presentation of this object. Of course, there is nothing what is limited to this method of presentation.
[0072] Next, the internal structure of the control unit shown in 12-3 in drawing 12 is explained using drawing 13 . 13-1 is a power cable and this is offered from the information terminal (12-1) shown in drawing 12 . This power cable is used for the control of a detector (13-3) and an analog-to-digital converter (13-6) represented by semiconductor laser, the light source (13-2) represented by the light emitting diode, an avalanche photodiode, and the photo-multiplier. Moreover, the light source and a detector are connected to the optical waveguide (13-5) represented by the optical fiber through an optical connector (13-4). The detector (13-3) represented by the avalanche photodiode and the photo-multiplier changes into an electric signal the body tissue transmitted light reinforcement which spread the optical waveguide (13-5) represented by the optical fiber, and digitizes it in an analog / digital transducer (13-6). And it transmits to an information terminal (12-1) using the cable for signal transmissions (13-7).
[0073] Optical measurement of the metabolite concentration reflecting a mental condition in the living body or its concentration change was carried out, and the measurement result was made to reflect in the example described above to the positional information of the object by which a screen display was carried out. The reflection approach as shown below besides such a reflection approach can be considered. Drawing 14 is the example of the approach of displaying change (an increment or reduction) of the blood volume accompanying a brain activity by changing the size of the object on a screen.
[0074] In drawing 14 , 14-2 is the size of the object in the blood volume used as criteria. A pair is carried out, and 14-1 and 14-3 show the size of the object at the time of decreasing, when blood volume increases to this blood volume which serves as these criteria respectively. The size of an object will become large if the blood volume within a brain can be increased by praying in the head "Become large" as concrete contents to the object (for example, the body is sufficient and the belly of a frog is sufficient) displayed on the screen. On the other hand, when the measurement location has shifted, it is also possible that blood volume decreases. In that case, the size of an object becomes small.
[0075] Drawing 15 is the example of the approach of displaying change (an increment or reduction) of the blood volume accompanying a brain activity by changing the color (a shade and class) of the object on a screen. 14-2 is the color (for example, red) of the object in the blood volume used as criteria. A pair is carried out, and 15-1 and 15-3 show the color of the object at the time of decreasing, when blood volume increases to this blood volume which serves as these criteria respectively. When the red of the color of criteria changes to crimson with the increment in blood volume, 15-2 shows the case where it changes to pink, with reduction in blood volume 15-1.
[0076] In addition, from the red of criteria, when blood volume increases, for example, changing to blue, and making it change to yellow, when it decreases etc. is considered. If the blood volume

within a brain can be increased by praying in the head, "Become blue!" as concrete contents to the object (the red of a signal is displayed) displayed on the screen, the thing that the color of an object becomes blue can be considered. On the other hand, when blood volume decreases, it is possible that the color of an object changes to another color (for example, yellow).
[0077] Next, the example (limiter) of the play equipment which is hard to carry out by impressing fatigue to an inspected object is shown. 16-1 in drawing 16 shows this example as a flow chart. The algorithm based on this flow chart is saved at the storage which exists in the computer shown in 1-8. Below, the outline of the flow chart shown in 16-1 is explained.
[0078] First, a game is started (16-2). And first, convention time amount is set up (16-3), and it saves at storage. This convention time amount is set up with 30 etc. minutes etc. Since a player will generally be devoted if this performs a game, he tends to forget to pass at the time. Consequently, it is for playing a long duration game and sensing unexpected fatigue. This convention measurement time amount can be set as arbitration according to the class of contents of a game, or the individual corporal description.
[0079] Next, a sample task is carried out (16-4). This presents "please move a hand" or "please remember that it was pleasant until now", and a message to an inspected object, passes in the living body using the optical exposure machine and photodetector which have been arranged on an inspected object, and detects change of the reinforcement of the transmitted light. Change of the detection light reinforcement to a resting period is set to x here, and this is also saved in storage (16-5). The threshold parameter k about change of transmitted light reinforcement is further set to this storage. It is possible to also set this threshold as arbitration according to the class of contents of a game or the individual corporal description.
[0080] And the game of Maine is performed. First, the accumulation measurement time amount after a game is started is found. If this accumulation measurement time amount is in convention measurement time amount (criteria exposure period), measurement will be continued, and measurement (game) will be interrupted if it is no (16-6). Next, the check of the change of transmitted light reinforcement is carried out (16-7), and it judges whether it is larger than the threshold (xxk) which the reinforcement set up, or small (16-8). When smaller than the threshold which change of transmitted light reinforcement set up, it continues a game (16-9). On the other hand, a game is interrupted when larger than a threshold (16-10). And the interrupted purport is shown to an inspected object (16-11), and the light source is turned off (16-12).
[0081] Next, how to carry out the check of the change of transmitted light reinforcement is explained using the following drawing 17 . First, as shown in 17-1 in drawing 17 (a), according to spacing of a certain time of day, the trigger for inspecting detection light reinforcement (transmitted light reinforcement) is emitted. Even if the recurrence interval of this trigger is spacing of not only regular intervals [like] but arbitration shown in drawing, it is satisfactory in any way. And corresponding to this trigger, the body tissue transmitted light reinforcement (detection light reinforcement) inputted into the computer is checked.
[0082] 17-2 in drawing 17 (b) shows one example of the check approach. 17-3 shows the time dependency of body tissue transmitted light reinforcement. Moreover, 17-4 shows in piles the timing by which the trigger shown in 17-1 was emitted on 17-2. Furthermore, 17-5 shows a certain predetermined threshold reinforcement. This threshold reinforcement is set as any value for every inspected object and every play equipment. In the case of 17-2, in the period 17-6, transmitted light reinforcement is less than threshold reinforcement.
[0083] Next, how to show the purport that measurement (game) was interrupted, to an inspected object is explained using drawing 18 . 18-1 in drawing is a computer, and this computer possesses the screen for a display (18-2), and the loudspeaker for voice presentation (18-3), in order to realize the play equipment reflecting the brain activity depending on organization propagation light reinforcement in the living body. As shown in drawing 1616 , in order to show the purport that measurement (game) was interrupted, to an inspected object, the message "game termination" is displayed in the first place on the screen for a display (18-2).
[0084] In other words, showing on a screen the message of the purport which ends a game, and the display of a screen are changed with during the usual game operation period. A message flows in the purport which ends measurement, for example, "game termination", from the

loudspeaker for voice presentation (18-3) by the same approach as this. Although the sound effect etc. is flowing in the usual game in order to raise the presence of a game from this loudspeaker, during a game operation period usual in audio presentation, it is the description in passing this message to make it change.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Drawing showing the equipment configuration (1) of play equipment based on living body light mensuration.
[Drawing 2] Drawing showing the image of the increment in concentration of cerebral structure, a living body intrinsic-light propagation property, and the metabolite in the living body accompanying a brain activity.
[Drawing 3] Drawing explaining the example of the method of presentation of the object displayed on luminous-intensity change which spread in the living body before and behind a brain activity period, and the screen reflecting the change on the strength.
[Drawing 4] Drawing showing two or more point mensuration - on the equipment configuration (2)-inspected object of play equipment based on living body light mensuration.
[Drawing 5] Drawing explaining the example of the method of presentation of the object displayed on the screen using the measurement result based on the living body light mensuration shown in drawing 4 .
[Drawing 6] Equipment configuration of play equipment based on living body light mensuration (3) - Drawing showing two or more coincidence mensuration [of a man inspected object] (1) -.
[Drawing 7] Equipment configuration of play equipment based on living body light mensuration (4) - Drawing showing two or more coincidence mensuration [of a man inspected object] (2) -.
[Drawing 8] Drawing showing a measurement sequence when realizing the play equipment shown in drawing 7 .
[Drawing 9] Drawing explaining the example of the method of presentation of the object displayed on the screen using the measurement result based on drawing 6 and the living body light mensuration shown in 7.
[Drawing 10] Equipment configuration of play equipment based on living body light mensuration (5) - Drawing showing two or more two or more point coincidence mensuration - on a man inspected object.
[Drawing 11] Drawing explaining the example of the method of presentation of the object displayed on the screen using the measurement result based on the living body light mensuration shown in drawing 10 .
[Drawing 12] Drawing explaining the example of the method of presentation of the object displayed on the screen using the somatometry method using an information terminal, and this measurement result.
[Drawing 13] Drawing showing the equipment configuration of the somatometry equipment linked to an information terminal.
[Drawing 14] Drawing explaining the example which presents the blood volume change accompanying a brain activity to an inspected object by changing the size of the object displayed on the screen.
[Drawing 15] Drawing explaining the example which presents the blood volume change accompanying a brain activity to an inspected object by changing the color of the object displayed on the screen.
[Drawing 16] Drawing showing the flow chart about the example (limiter) of the play equipment in

which it is hard to impress fatigue to an inspected object.
[Drawing 17] It is an explanation **** Fig. about one example of the algorithm which judges termination of measurement (or game) of a limiter.
[Drawing 18] Drawing explaining an example of the practice of game interruption.
[Drawing 19] Drawing explaining the living body input unit and biological control equipment using the Mitsuo object mensuration.
[Description of Notations]
1-1: The light source represented by semiconductor laser, light emitting diode, and the lamp, 1-2:optical waveguide, a 1-3:inspected object, the optical fiber for 1-4:detection, a 1-5:photodetector, a 1-6:control device, a 1-7:analog-to-digital converter, a 1-8:computer, Screen 2-1 for a 1-9:display : optical waveguide for an optical exposure, optical waveguide for 2-2:detection. An inspected object, a 2-4:skull, a 2-5:cerebrospinal fluid layer, 2-6 : 2-3: The cerebral cortex, 2-7: Blood volume 3-1 in the cerebral cortex : The related example of luminous intensity and measurement time amount which penetrated the body tissue, 3-2 : One example of contents, a 3-3:balloon, 3-4:ground 4-1:semiconductor laser, The light source represented by a light emitting diode and the lamp, a 4-2:control device, 4-3 : The optical waveguide represented by the optical fiber, Optical coupling machine : An optical coupling machine, the optical waveguide represented by the optical fiber of 4-5:plurality, 4-6: Inspected object 4-7 : The optical waveguide represented by the optical fiber for detection, 4-8 : An avalanche photo-diode, the photodetector represented by the photomultiplier tube, 4-9 : An analog-to-digital converter, 4-10:screen control equipment, the 4-11:display screen 5-1:display screen, 5-2 : Kawagishi, a 5-3:canoe, the 5-4:upstream, a 5-5:lower stream of a river, 5-6:obstruction 6-1:semiconductor laser, The light source represented by a light emitting diode and the lamp, a 6-2:control device, 6-3 : The optical waveguide represented by the optical fiber, 6-4: An optical coupling machine, 6-5 : The optical waveguide represented by two or more optical fibers, 6-6: The inspected object 1, the 6-7:inspected object 2, 6-8 : The optical waveguide represented by the optical fiber for detection, 6-9 : An avalanche photo-diode, the photodetector represented by the photomultiplier tube, 6-10 : An avalanche photo-diode, the photodetector represented by the photomultiplier tube, 6-11 : An analog-to-digital converter, 6-12:screen control equipment, 7-1:semiconductor laser, The light source represented by a light emitting diode and the lamp, a 7-2:control device, 7-3 : The optical waveguide represented by the optical fiber, 7-4: An optical coupling machine, 7-5 : The optical waveguide represented by two or more optical fibers, 7-6: The inspected object 1, the 7-7:inspected object 2, 7-8 : The optical waveguide represented by the optical fiber for detection, 7-9: An optical coupling machine, the optical waveguide represented by the 7-10:optical fiber, 7-11 : An avalanche photo-diode, The photodetector, 7-12 which are represented by the photo-multiplier : An analog-to-digital converter, 7-13: The pulse for control, 8-2 which are emitted to an optical coupling machine (7-4) from screen control equipment, the 7-14:display screen, the circuit for 7-15:control-command transmission, and a 8-1:control unit (7-2) : The optical fiber for an exposure (7-5) is minded. The optical reinforcement, 8-3 which are irradiated to the inspected object 1 (7-6) : The optical fiber for an exposure (7-5) is minded. The optical reinforcement, 8-4 which are irradiated to the inspected object 2 (7-7) : The luminous intensity which spread the interior of the inspected object 1 (7-6) detected by the optical waveguide (7-8) represented by the optical fiber for detection, 8-5 : by the optical waveguide (7-8) represented by the optical fiber for detection The indicator 10-1 which displays the difference of blood volume change (B1) of the luminous-intensity 9-1:inspected object 1 which spread the interior of the detected inspected object 2 (7-7), the 9-2:inspected object 2, and the 9-3:inspected object 1, and blood volume change (B-2) of the inspected object 2 : Semiconductor laser, light emitting diode, The light source represented by the lamp, a 10-2:control device, 10-3 : The optical waveguide represented by the optical fiber, 10-4: The inspected object 1, the 10-5:inspected object 2, 10-6 : The optical waveguide represented by the optical fiber for detection, 10-7 : An avalanche photo-diode, the photodetector represented by the photomultiplier tube, 10-8 : An analog-to-digital converter, 10-9:screen control equipment, the 10-10:display screen 11-1:display screen, 11-2: — Kawagishi, the 11-3:canoe 1, the 11-4:canoe 2, and the 11-5:upstream — 11-6 : The location of a lower stream of a river, a 11-

7:obstruction, and the canoe 1 in the inside of the river which changed to 11-8:time series, 11-9 : The location of the canoe 1 in the inside of the river which changed to time series, a 12-1:information terminal, 12-2 : The control unit that whose the display screen, the 12-3:light source, and a detector are provided it is the description, 12-4: The optical fiber for an exposure, the optical fiber for 12-5:detection, 12-6 : An inspected object, 12-7: The object 13-1 reflecting a brain activity : A power cable, 13-2 : The light source, the 13-3:avalanche photodiode which are represented by semiconductor laser and the light emitting diode, The detector, 13-4 which are represented by the photo-multiplier : An optical connector, 13-5 : The optical waveguide, the 13-6:analog / digital converter represented by the optical fiber, 13-7: The cable for signal transmissions, 14-1 : An object when blood volume increases, 14-2 : An object when the object in the blood volume used as criteria and 14-3:blood volume decrease, 15-1 : An object when blood volume increases, the object in the blood volume used as 15-2:criteria, 15-3 : An object when blood volume decreases, the flow chart of the example (limiter) of the play equipment in which it is hard to impress fatigue to a 16-1:inspected object, 17-1: Trigger generating timing, 17-2 : One example of the check approach, 17-3: The time dependency of body tissue transmitted light reinforcement, 17-4 : Trigger generating timing, 17-5 : The period when a certain threshold reinforcement and 17-6:transmitted light reinforcement were less than threshold reinforcement, 18-1 : A computer, the screen for a 18-2:display, the loudspeaker for 18-3:voice presentation, 19-1 : The light source represented by semiconductor laser, light emitting diode, and the lamp, 19-2: A photoelectric element, 19-6 which are represented by the optical waveguide represented by the optical fiber for an exposure, a 19-3:inspected object, the optical waveguide represented by the 19-4:optical fiber, a 19-5:photodiode, and the photomultiplier tube: Computer.

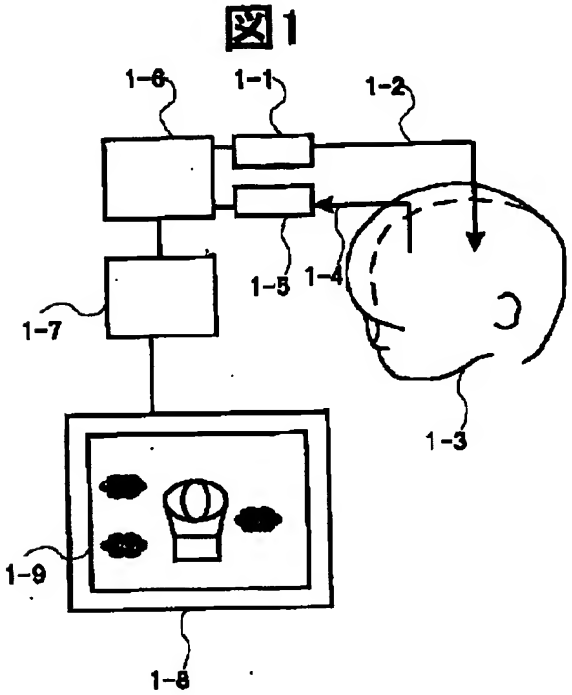
[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

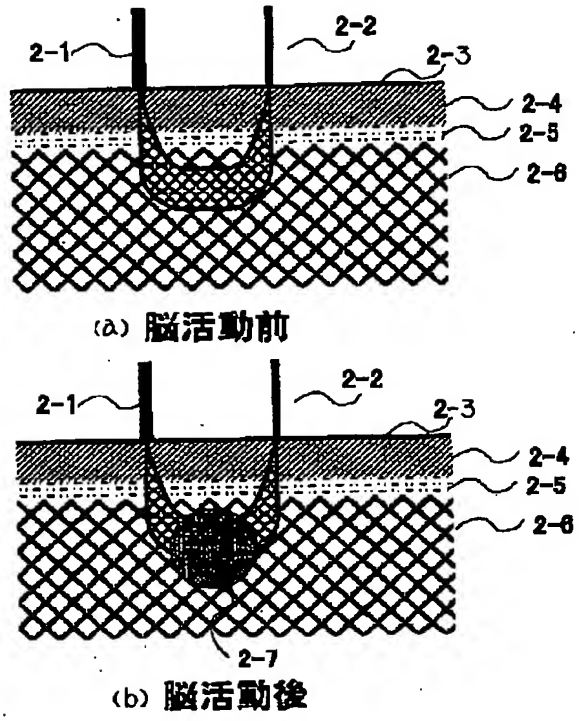
DRAWINGS

[Drawing 1]



[Drawing 2]

図2



[Drawing 3]

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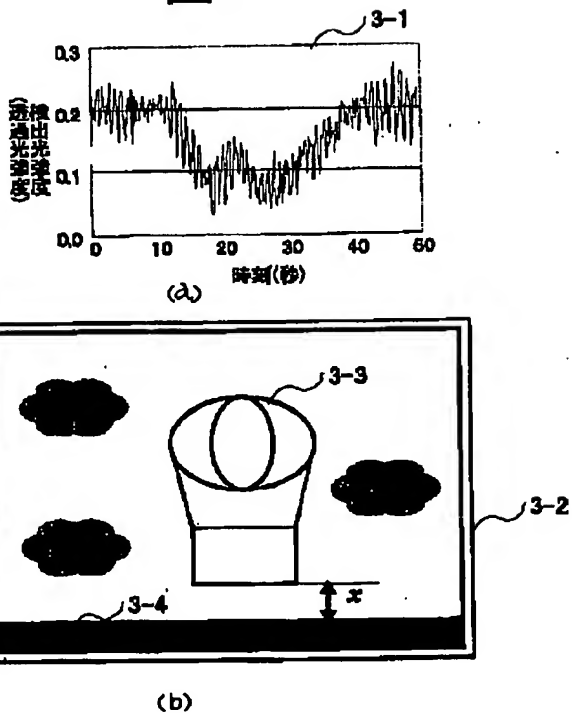

[Drawing 4]

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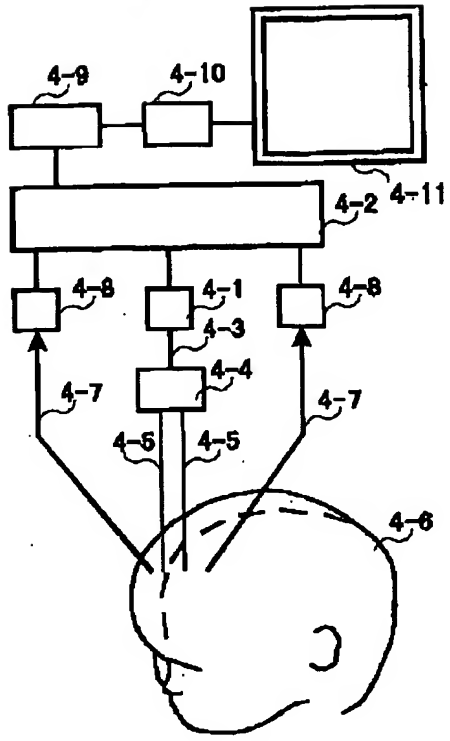

[Drawing 5]

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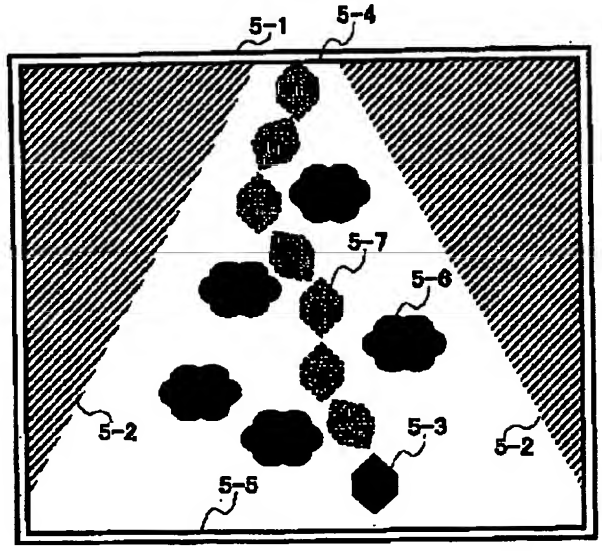

[Drawing 6]

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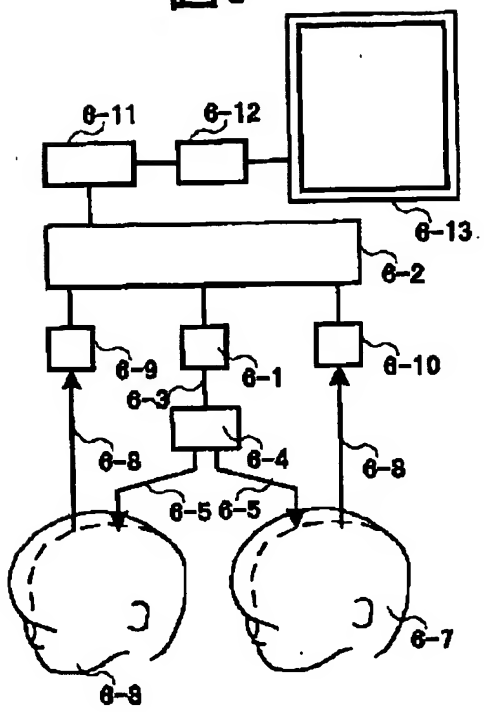

[Drawing 7]

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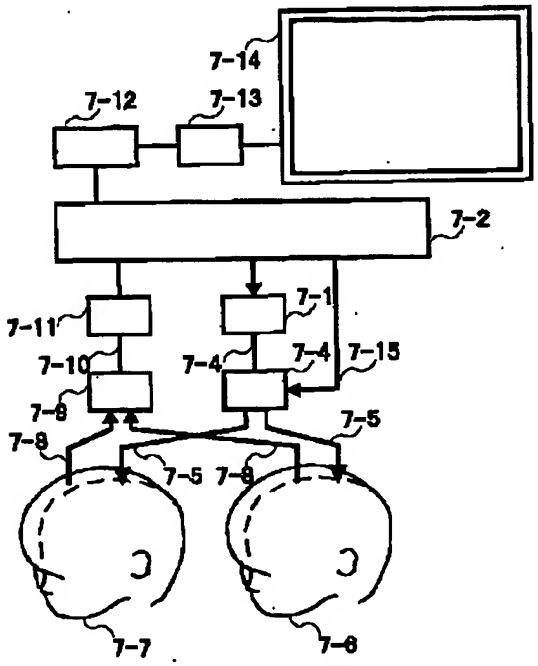

[Drawing 8]

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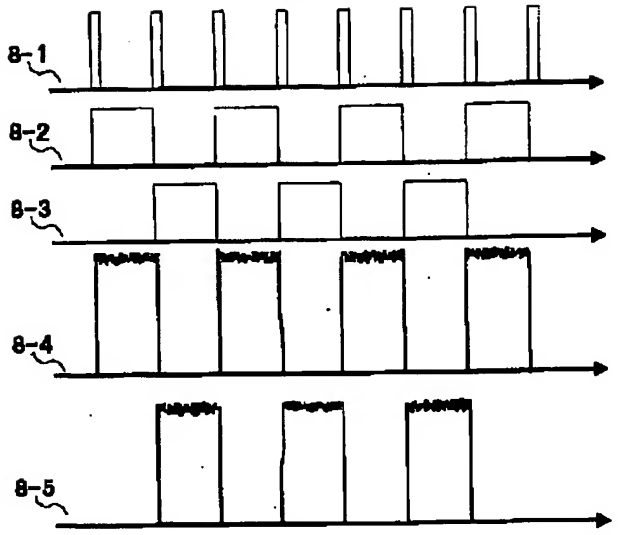
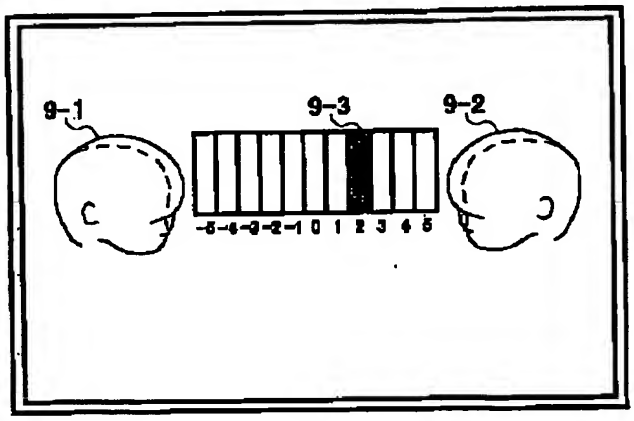


[Drawing 9]

図9



[Drawing 10]

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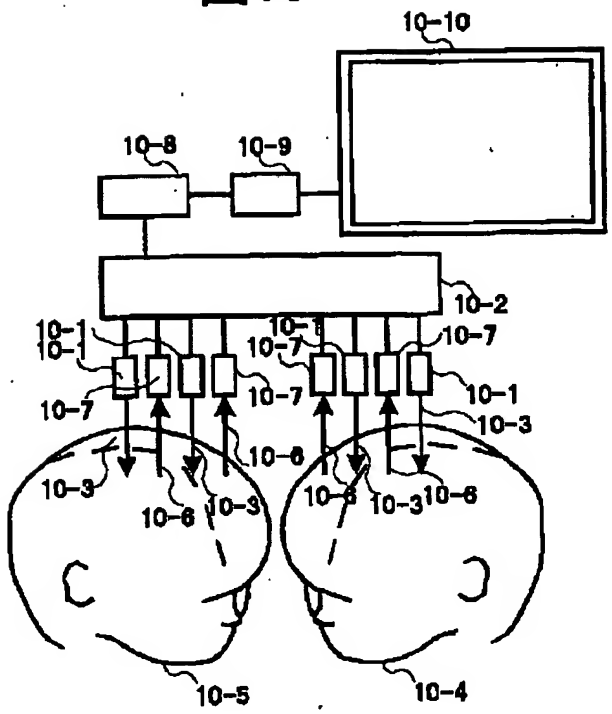

[Drawing 11]

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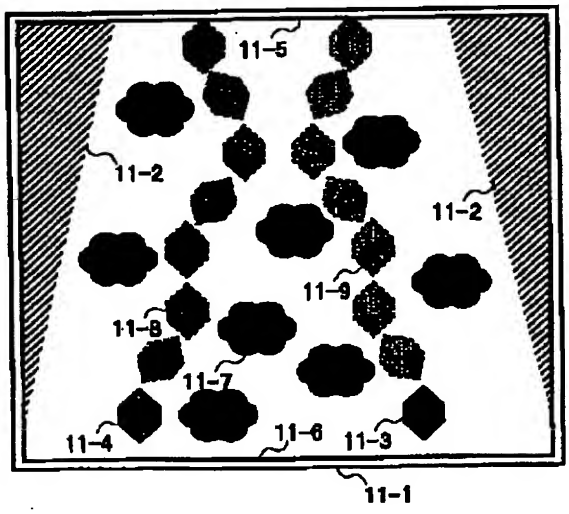
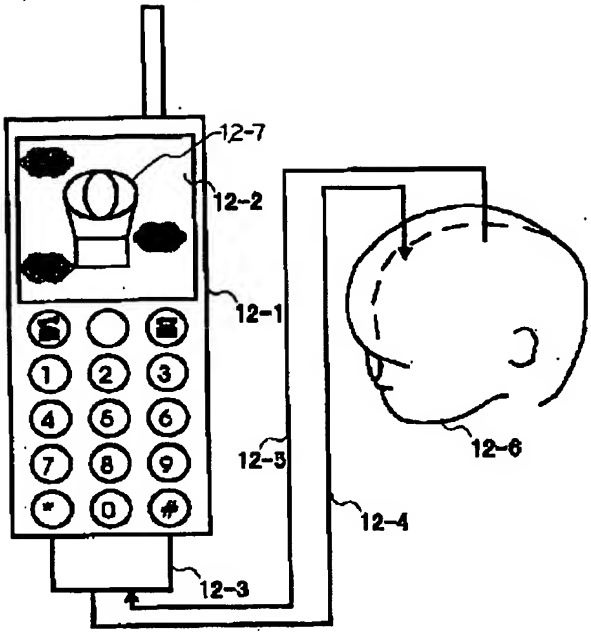


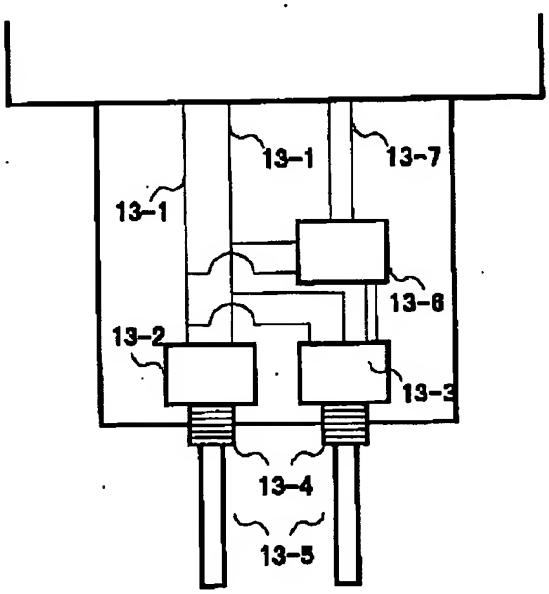
[Drawing 12]

図12



[Drawing 13]

図13



[Drawing 14]

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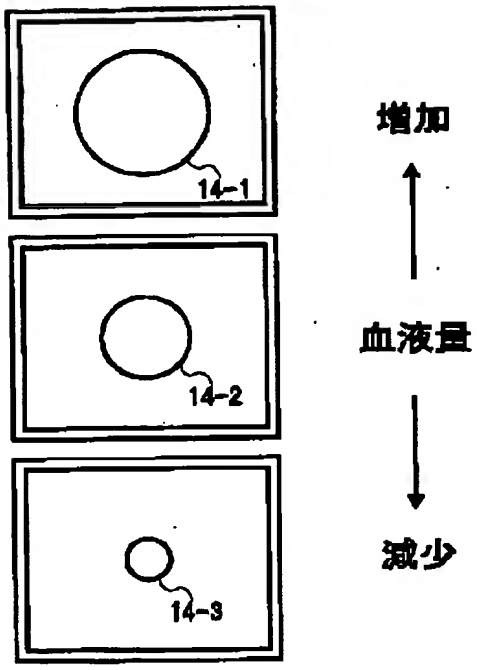

[Drawing 15]

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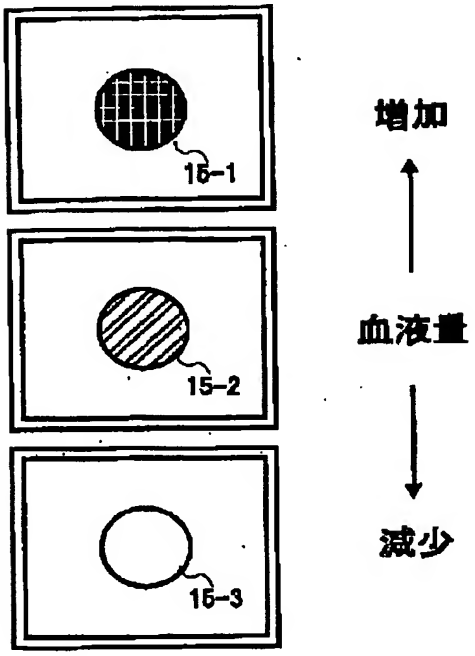
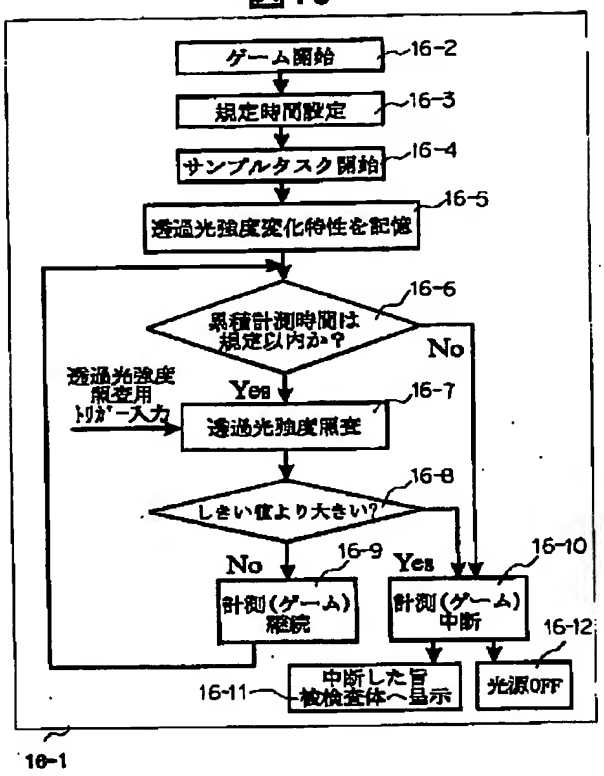


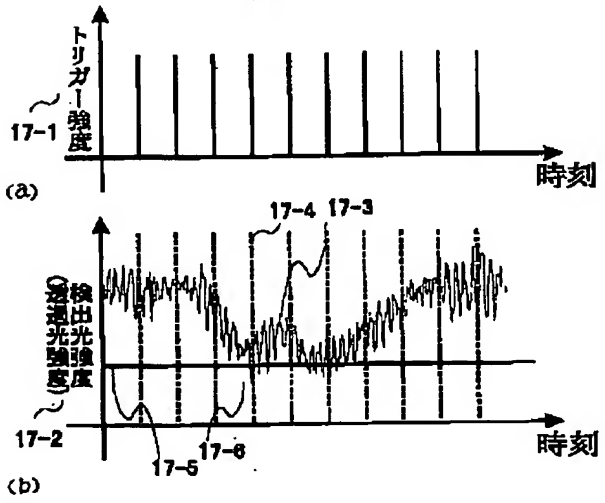
[Drawing 16]

図16



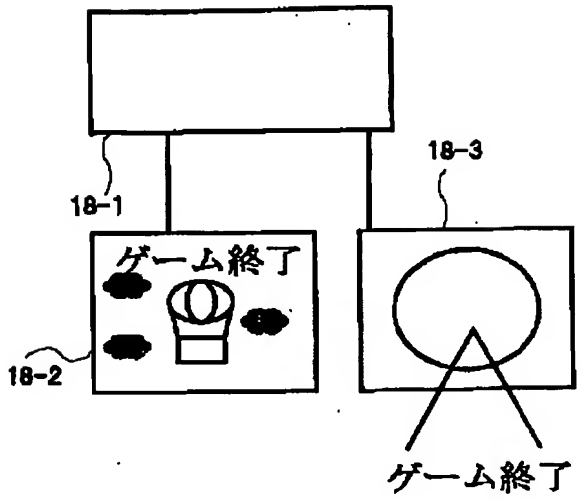
[Drawing 17]

図17



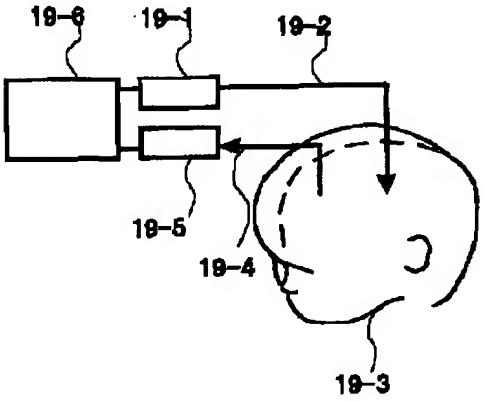
[Drawing 18]

図18



[Drawing 19]

図19



[Translation done.]